Appendix 5-G

Tank Seam Access Road

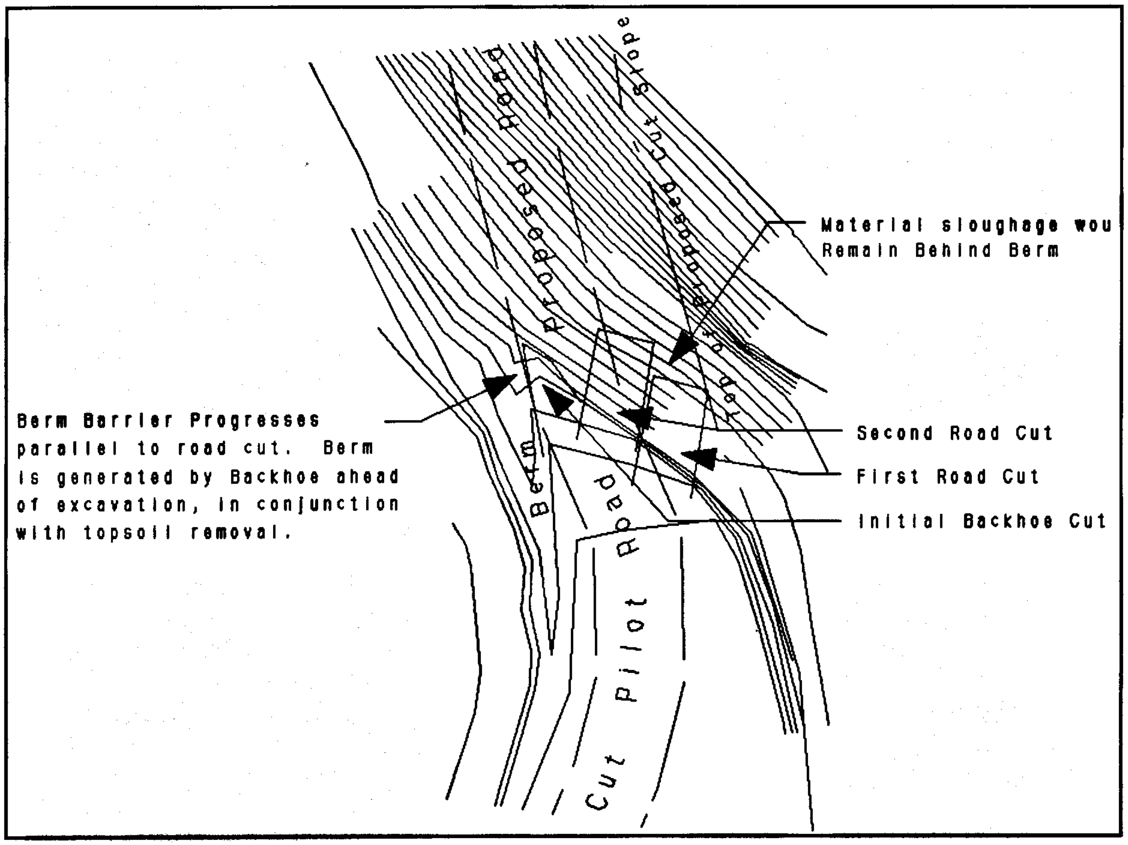
This appendix discusses the construction of the Tank Seam Access Road and Tank Seam Portal Pad. In order to clearly complete proper out and fill calculations for the road, the road has been divided into stations spaced at approx. 100 ft o.c. as shown in Figure 3H-4. A cross section of each station follows Figure 5G-4. Stations 0+00 and 1+00 lie on the Upper storage Pad, Station –1+00 to the North on the existing road and Station 2+00 to the south on the lowest end of the Tank Seam Road. The station numbers increase as you proceed up the road toward the pad.

Construction will begin on the Upper Storage Pad. Construction will consist of removing topsoil for storage, then removing material from the road cut and compacting in onto the Upper Storage Pad. Topsoil removal and storage is discussed in section R645-301-240. Table 5G-1 shows the cut and fill volume calculations. Volume in the table represent total cut and fill material will be placed in the area of stations 8+00 and 9+00.

During the initial road cut, care will be taken to prevent disturbed material form migrating downslope in the following manner. The initial topsoil removal will be made using a backhoe. Trees and/or shrubs immediately ahead of the cut will be removed by pulling them back into the previous cut. Using the backhoe, a berm will be created on the downhill side of the cut, as shown in Figure 5G-1. When the berm is in place, the road cuts will be started as shown in Figure 5G-1 using a backhoe and/or front-end loader. The road cuts will be made into the slope towards the cut face rather than parallel to the slope, which will result in any rocks or sloughage dislodged by the equipment bucket during the road cutting to be contained within the berm. In the event blasting is required, which is described in Appendix 5-E, the blasts will be designed to drop the material in to cut area behind the berm. This will prevent material generated by the blast form migrating downslope into the undisturbed area. This procedure will de used to cut a pilot road until the first large fill area. This procedure will be used to cut a pilot road until the first large fill area (Stations 8+00 and 9+00) is reached.

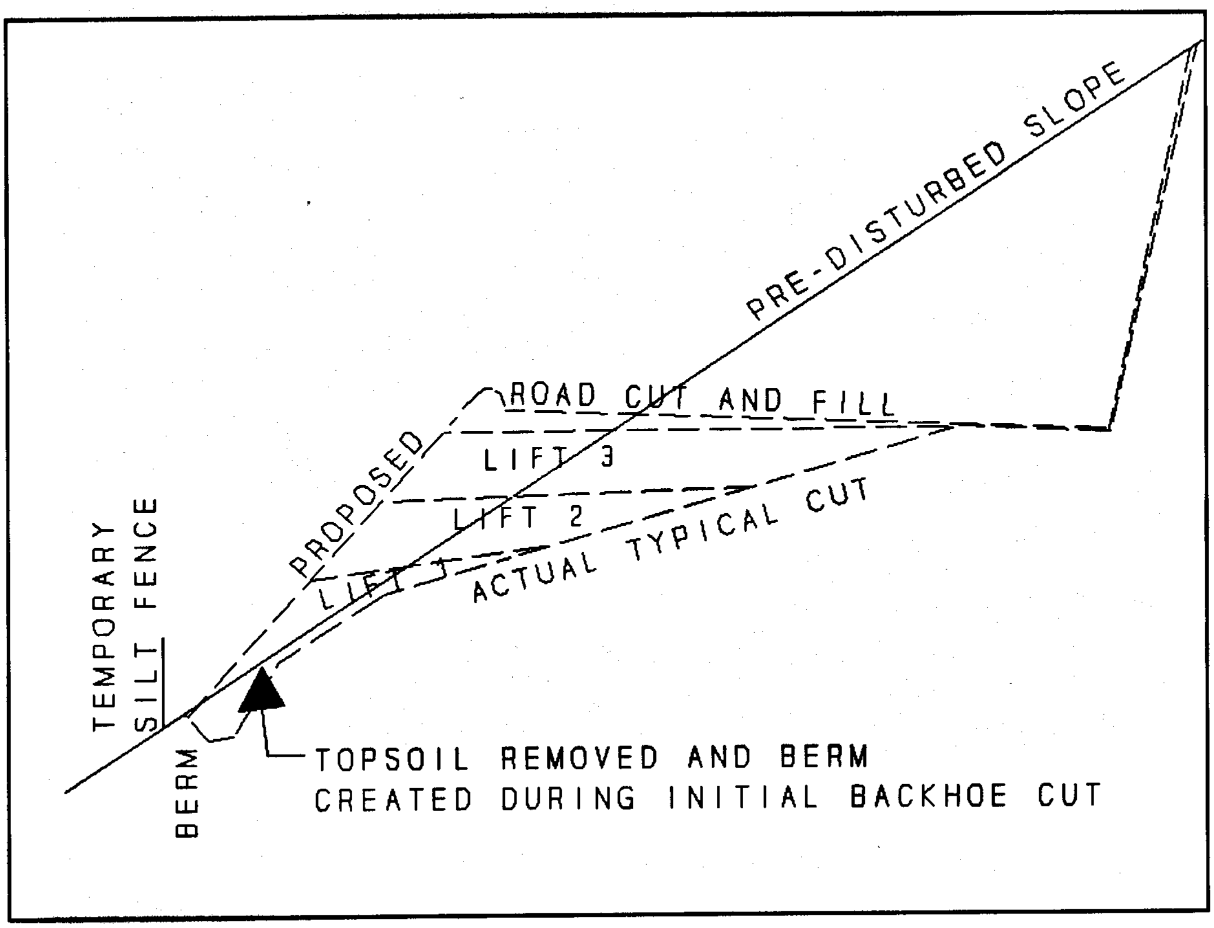
When small fill areas are reached (e.g. Station 6+00), a temporary silt fence will be installed at the base of the proposed fill for runoff control, and the same cutting procedure will be used to create an initial berm inside the silt fence with a backhoe after topsoil removal. The area inside the berm will then be prepared to allow the placement of the fill, as shown in Figure 5G-2. Fill material in these areas will be restricted to no more than 15' downslope form the road, allowing a backhoe to easily reach the material during reclamation. Rock fragments larger than 18 inches which are disturbed will be embedded into the surface of the fill as described in the slope stability analysis on page 5G-48. These areas are included in the disturbed area, and are designated as BTCA areas (See Plate 7-1E and Appendix 7-K). As soon as the fill material is in place, erosion control matting will be placed on the disturbed slopes as described on Appendix 7-K. The temporary silt fence at the base of the fill material will remain in place for runoff treatment until installation of the erosion control matting is complete.

Figure 5-G-1. Typical Road Excavation Sequence



NOTE: Road cut sequence may vary. All cuts will be made behind the berm generated by the initial backhoe cut.

Figure 5G-2. Cut and Fill Diagram for Small Areas



NOTE: This diagram represents a typical sequence for the construction of small fills alongside the cut road. Configurations shown are typical and the actual profile may vary.

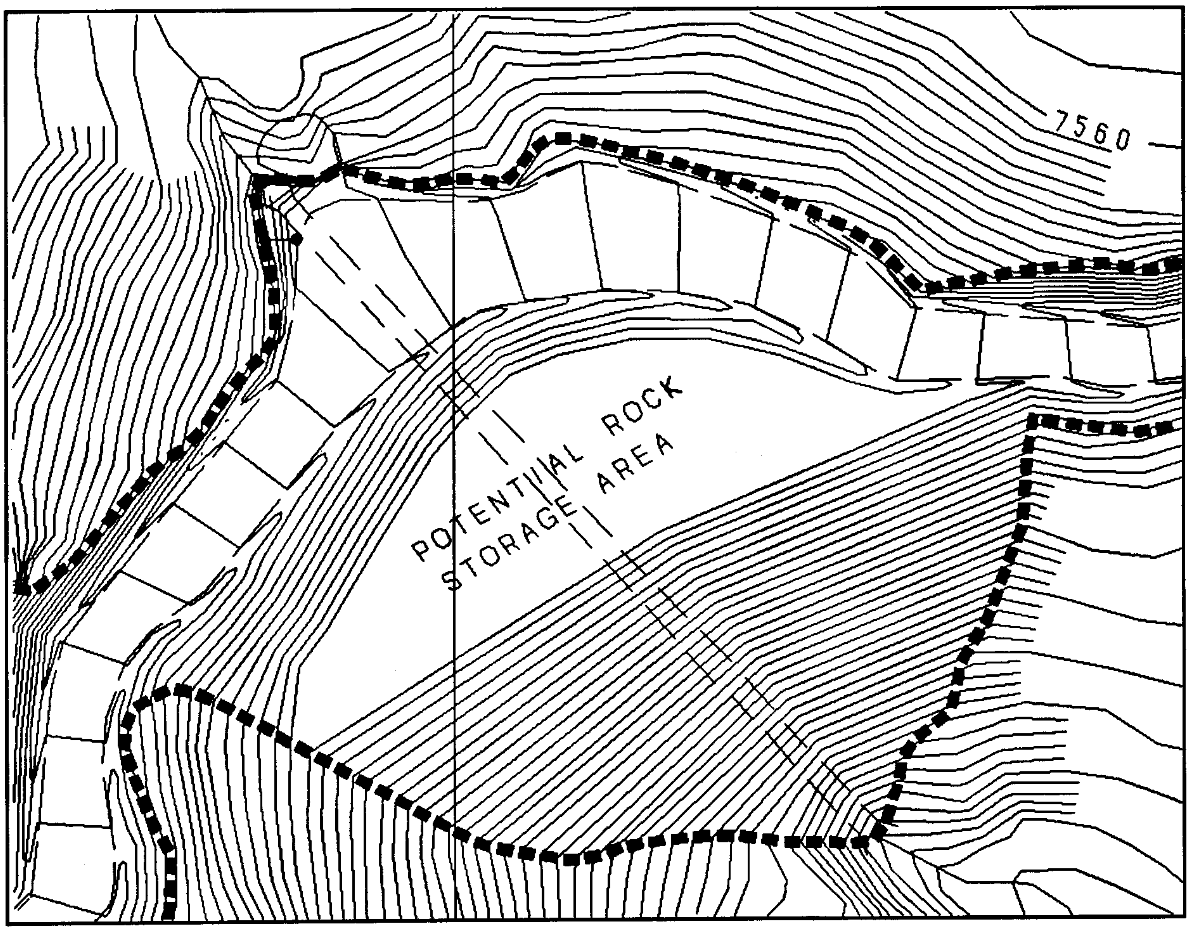
When the large fill area is reached, temporary silt fences will be placed below the fill area prior to equipment entering the proposed disturbed area. The silt fences will be placed so as to treat runoff from all disturbed area not contained by a berm during construction. Topsoil recovery will then begin in the fill area. During topsoil removal a ramp will be constructed which will weave back and forth along the face of the fill area to the base.

As the base of the fill area is approached, care similar to the procedures described previously for cut and fill will be taken to prevent rocks and other material form being pushed onto or below the silt fences. The following sequence will then be used starting at the base of the fill area.

The base of the fill area will be prepared according to the recommendations on Page 5G-48 by removing all vegetation and rock fragments larger than 18 inches which are not embedded into the natural ground and/or stable, and any cobble or boulder sized rocks which are positioned so as to interfere with the compaction activities. Placement of the fill material will then begin and the material will be compacted in lifts not exceeding 18 inches. The initial cut to reach the base of the fill area will act as a series of terraces with which the fill material can be keyed into the natural soils, as recommended on page 5G-48. As the fill progresses up the slope, removal of rock fragments and vegetation will continue on the slope above the fill. Rock fragments less than 18 inches will be incorporated into the fill as they are removed. Rock fragments larger than 18 inches will be incorporated into the surface of the fill and will be embedded into the fill material to aid the surface, remaining rocks will be temporarily placed on the Upper Storage Pad until construction of the road is complete, and then will be placed as described below according to the discussion on page 5G-48.

The cut and fill volume in Table 5G-1 represent the maximum amount of fill which will be encountered in the road excavation. The possible presence of excessive rock fragments larger than 18 inches may generate a reduced amount of fill and rocks which may need to be stored until reclamation. The extreme width of the road at stations 8+00 and 9+00 account for the maximum amount of fill material, which may be encountered. Excessive rock fragments could decrease the available fill. If this scenario is encountered, an alternate configuration, involving terracing of the fill, would provide a stable surface for which to store the additional rocks encountered during construction. If additional storage area is required, the necessary amount of area will be obtained by redesignating part of the Upper Storage Pad for storage of these rocks. These storage areas will be level or near level, so as to meet the requirements of R645-301-535. Rock fragments will be placed in single lifts as described on page 5G-48, in order to guarantee the safety factor requirements of R645-301-535.

Figure 5G-3. Alternate Fill Area Configuration.



Scale: 1" = 40'

Note: This figure represents an alternate fill configuration to account for the potential lack of fill material due to excessive large rocks (>18" m.d.). The elevation of the terrace may be lower than shown, or the terrace area may consist of more than one terrace, depending on the amount of fill available and amount of rocks encountered. As excavation progress, the amount of fill will be monitored. Approximately 3900 sq. ft. of terrace area is available for potential rock storage area (0.09 acres).

As the fill material is placed and compacted, the surface of the slope will be scarified and ripped horizontally to create a rough surface and water-holding pockets for interim vegetation, along with the embedded rocks. Erosion control matting will be installed in junction with the filling and compacting to prevent erosion form occur9ng on the fresh slopes. The matting will provide erosion and runoff control, and will aid in the establishment of interim vegetation. The matting will be maintained on the slopes as the primary BTCA treatment (Appendix 7-K), and will be maintained until an adequate demonstration that interim vegetation qualifies the slopes for designation as SAE (Small Area Exemption) areas. Division approval will be required before this designation can be made. Temporary silt fences will be removed once the installation of the matting is complete.

Culverts will also be installed on the fill slope as construction progresses up the slope, in order to avoid disturbance of the surface after construction. Culvert outlets will be protected as described in R645-301-742.300.

The cut and fill methodologies in the Appendix will be used throughout the construction of the road and the portal pad. As construction of the pilot road progresses, temporary ditches which meet the designs specifications of the permanent ditches will be maintained along the pilot read, with silt fences placed just above the culvert inlets treating any runoff. Approximate silt fences locations are shown on Plates 7-1C and 7-1E. Upon completion of construction, final as-built contours will be submitted to the Division.

Final crowning of the road and installation of permanent ditches will be completed following initial road and pad contouring. The approximate road and pad contours are shown on Plates 5-2.

A slope stability analysis of the cut slopes and fill areas, as well as some discussion on the construction methodology, is on page 5G-44 following the cross sections.

Upon completion of regarding activities, interim stabilization of the cut slopes will be accomplished through hydroseeding as described in R645-301-331. Cut slopes will be seeded using the seed mix an mulch described in Tables 3-3 and 3-4. Downslopes will be seeded by hand prior to the placement of erosion control matting using the permanent seed mix shown in Table 3-3. This seed mix will be used in order to establish shrubs as well as grasses to aid in interim stability.

The final as-built cut and fill material volumes are shown in Table 5G-2 on pg. 5G-71.

During reclamation 1,000 yds^3 of material was hauled from TS-15 as described on page 5J-13. Because of this 1,000 yds^3 of material will be left in TS-8 for use in reclamation in that area.

Figure 5G-4. Tank Seam Road/Pad Stations Map

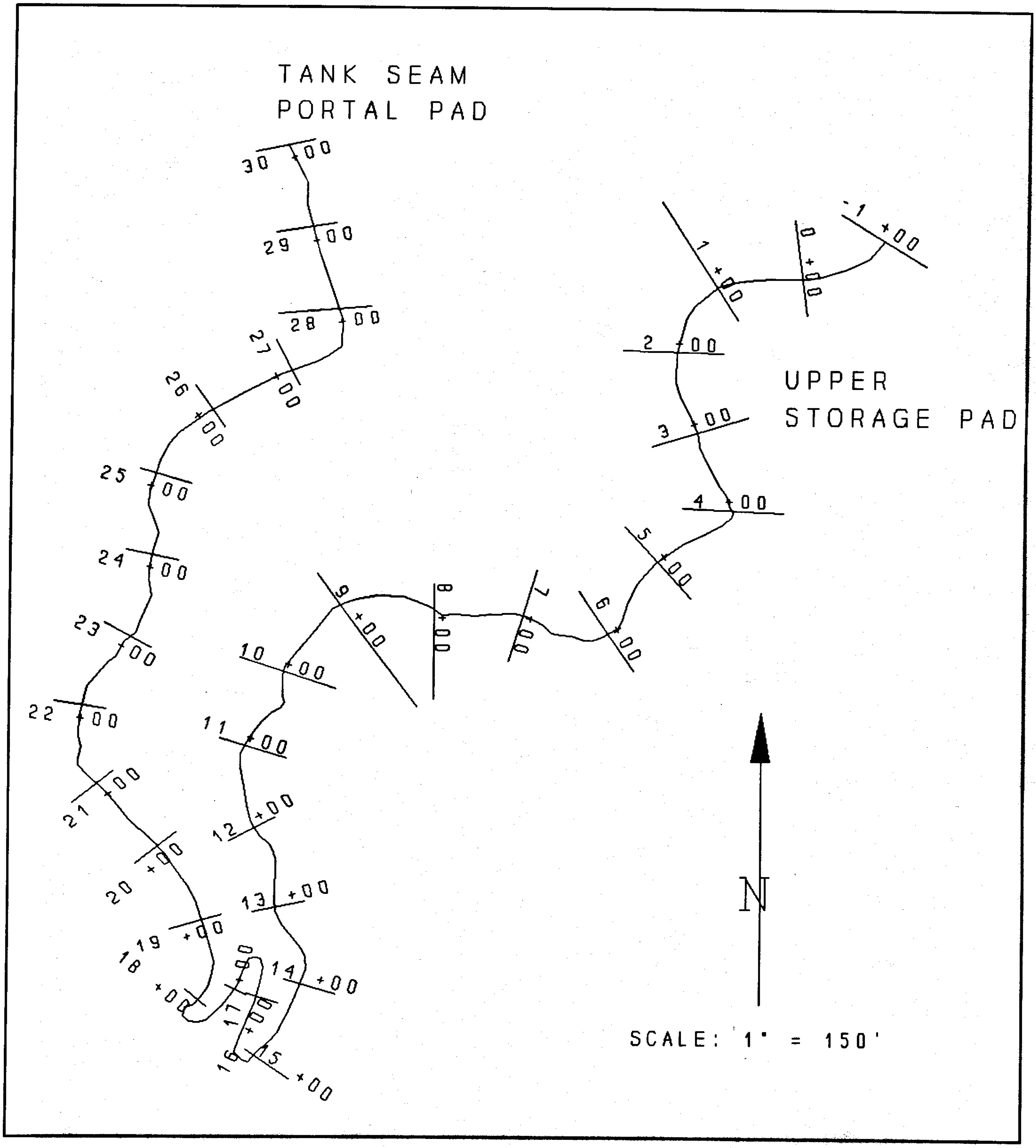
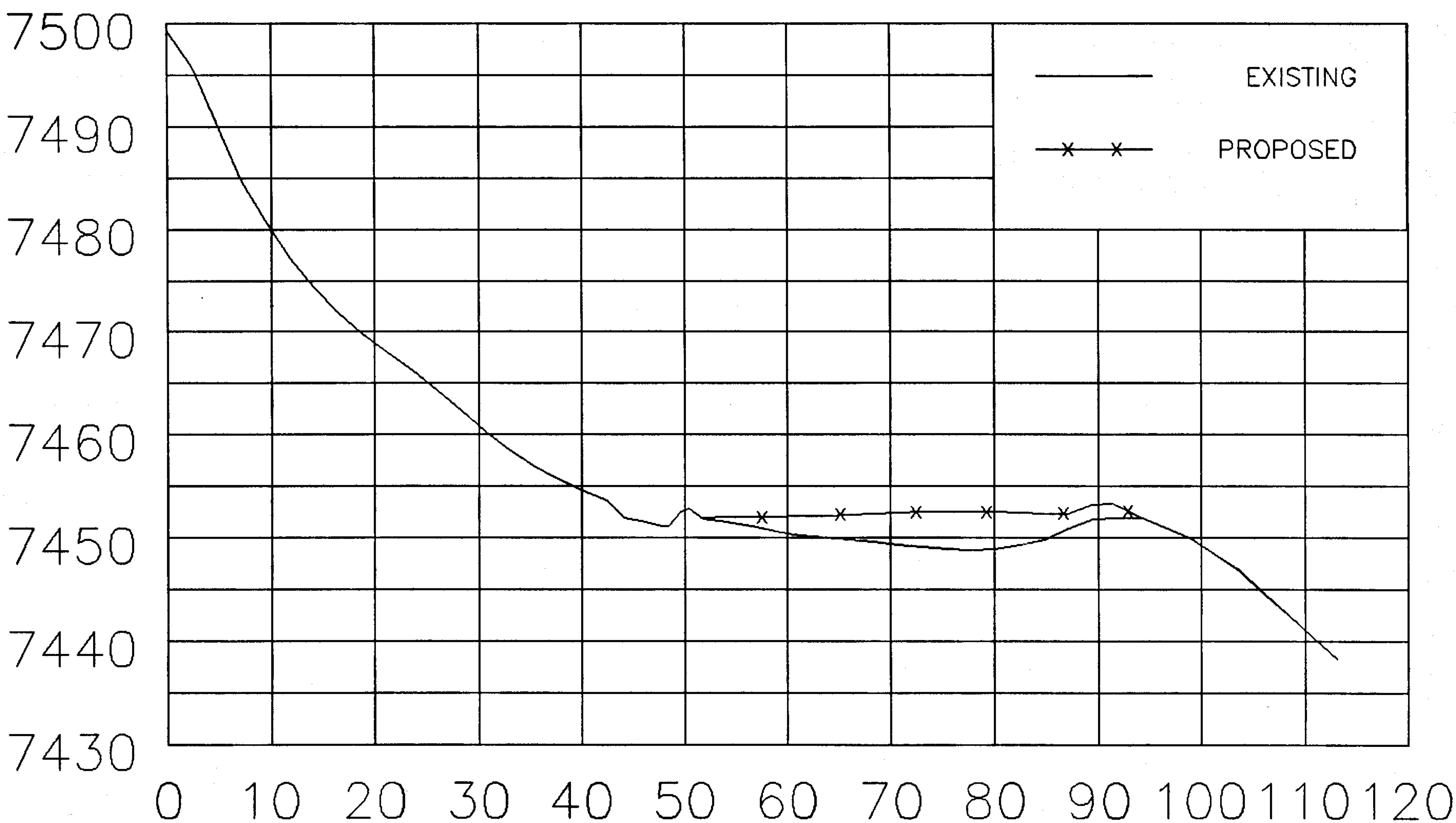


Table 5G-1. Tank Seam Road Cut & Fill Summary

Station	Fill (-) Volume (cu yd)	Cut (+) Volume* (cu yd)	Volume Cumul. (cu yd)	Station	Fill (-) Volume* (cu yd)	Cut (+) Volume* (cu yd)	Volume Cumul. (cu yd)
-1+00			0	15+00			-12,764
0+00	456	0	-456	16+00	300	69	-12,995
1+00	2,084	0	-2,084	17+00	140	236	-12,899
2+00	2,419	0	-4,959	18+00	175	299	-12,775
3+00	631	367	-5,223	19+00	0	550	-12,225
4+00	68	802	-4,489	20+00	0	871	-11,354
5+00	53	669	-3,873	21+00	0	796	-10,558
6+00	139	386	-3,624	22+00	0	819	-9,739
7+00	68	480	-3,214	23+00	0	642	-9,097
8+00	3,025	122	-6,117	24+00	0	713	-8,384
9+00	7,145	0	-13,262	25+00	822	83	-9,123
10+00	498	526	-13,234	26+00	269	536	-8,856
11+00	779	258	-13,755	27+00	0	1,265	-7,591
12+00	0	676	-13,079	28+00	0	4,528	-3,063
13+00	0	741	-12,338	29+00	0	1,994	-1,069
14+00	150	266	-12,222	30+00	0	1,110	41
15+00	1,089	547	-12,764		20,310	20,351	

*Cut and fill volumes measured using Quicksurf Version 4.0 3-D molding software package, copyright 1991, Schreiber Instruments, Inc., based on premining contours from 1991 aerial survey and proposed contours shown on Plate 5-2E.

STATION 0+00



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120
EXISTING
PROPOSED

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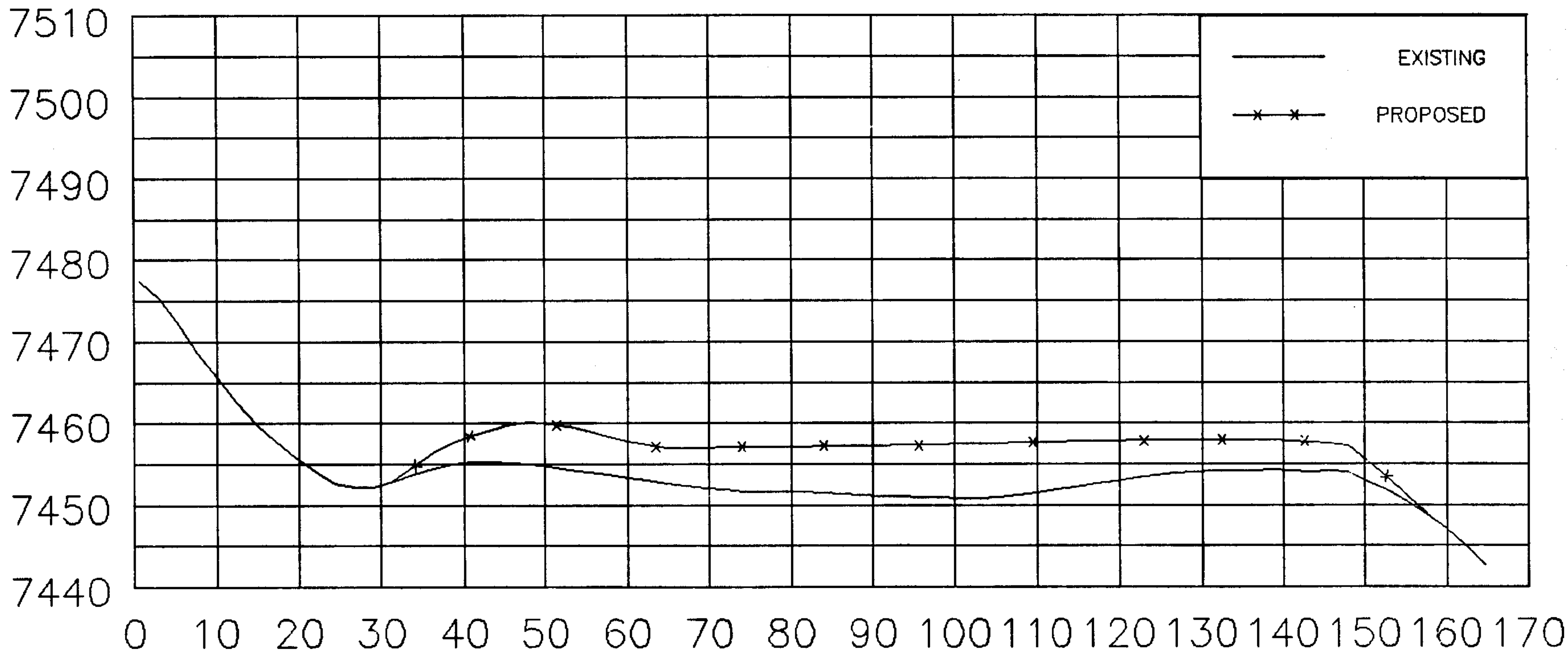

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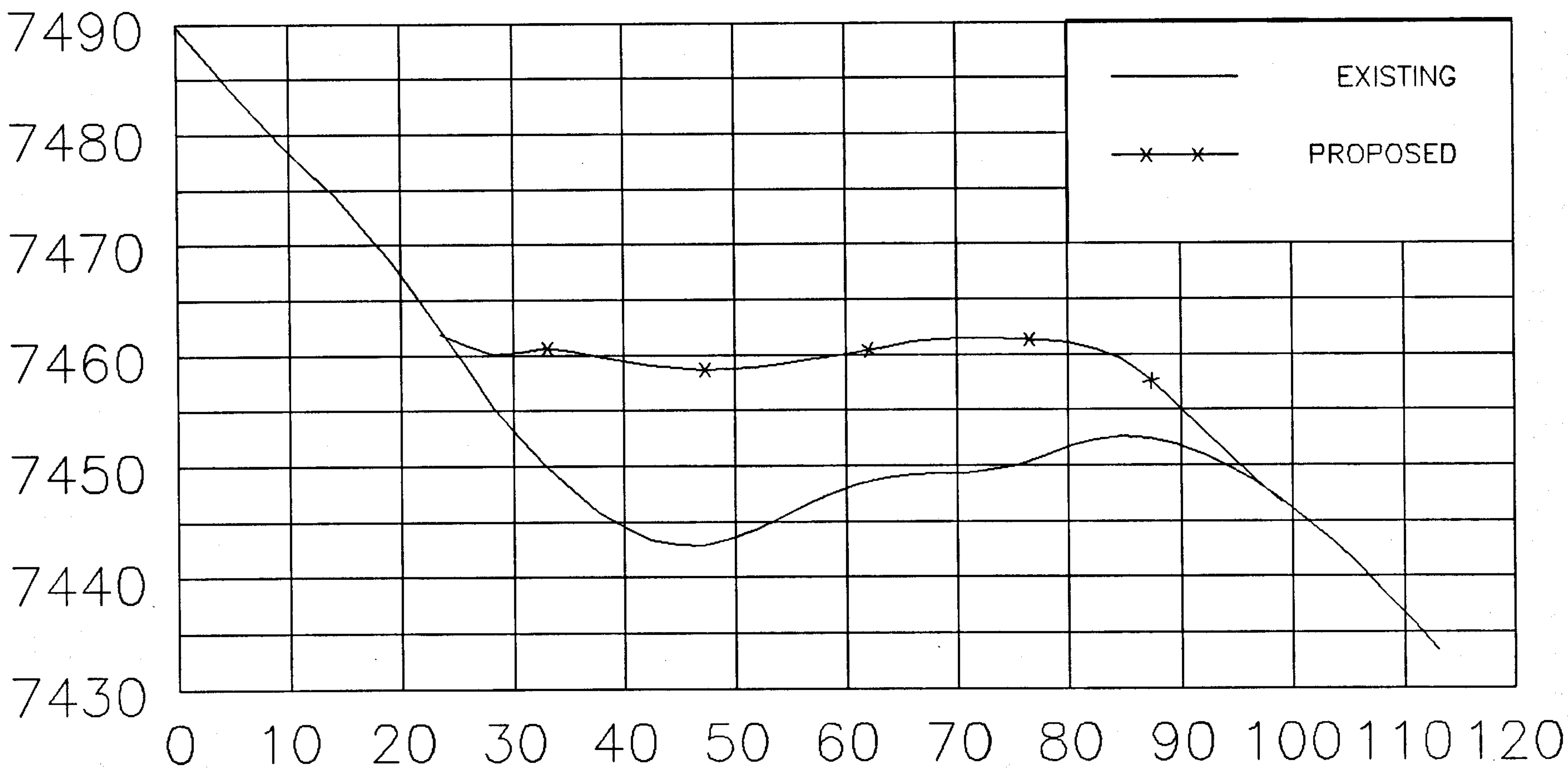
150
160
170

STATION 2+00



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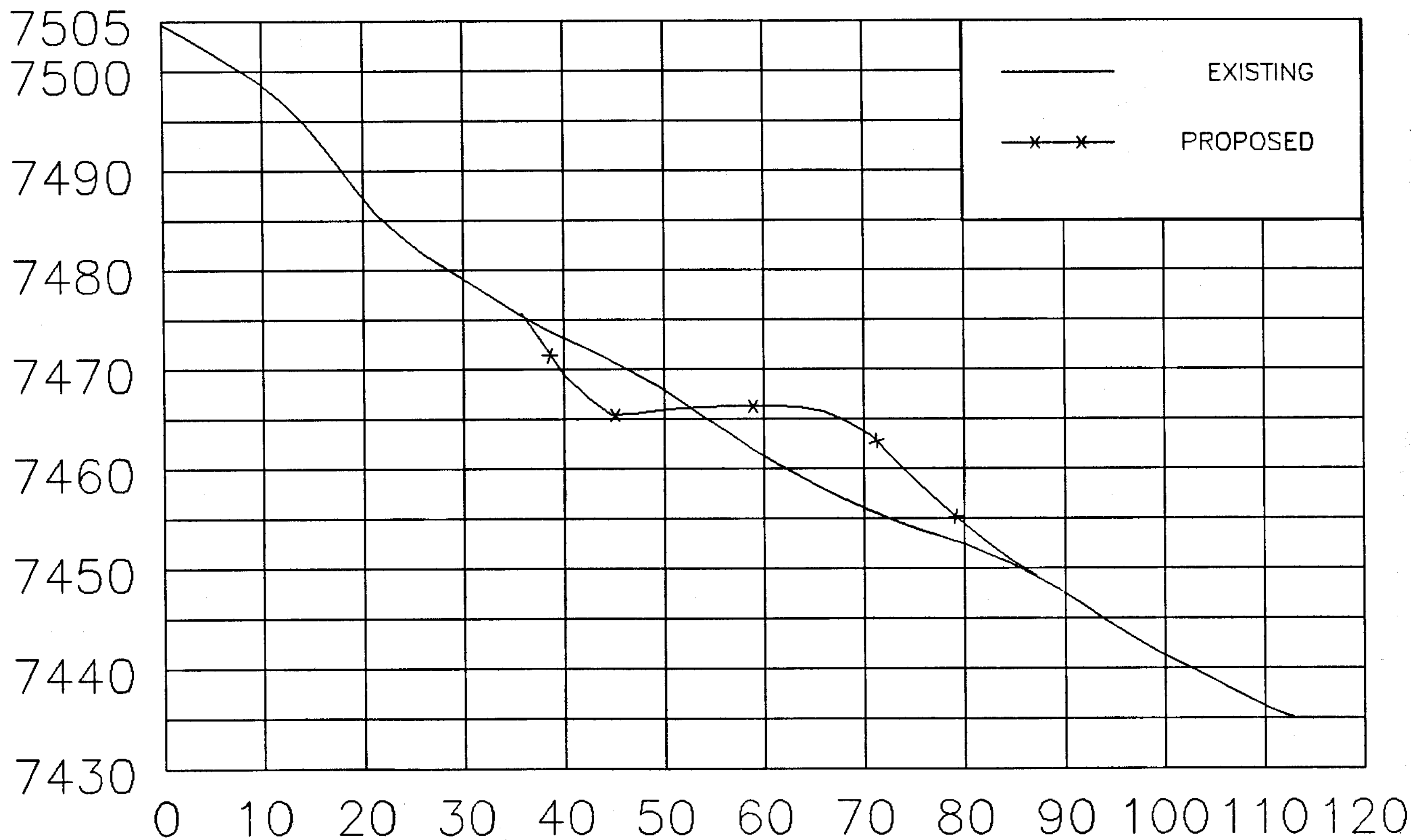
STATION 3+00



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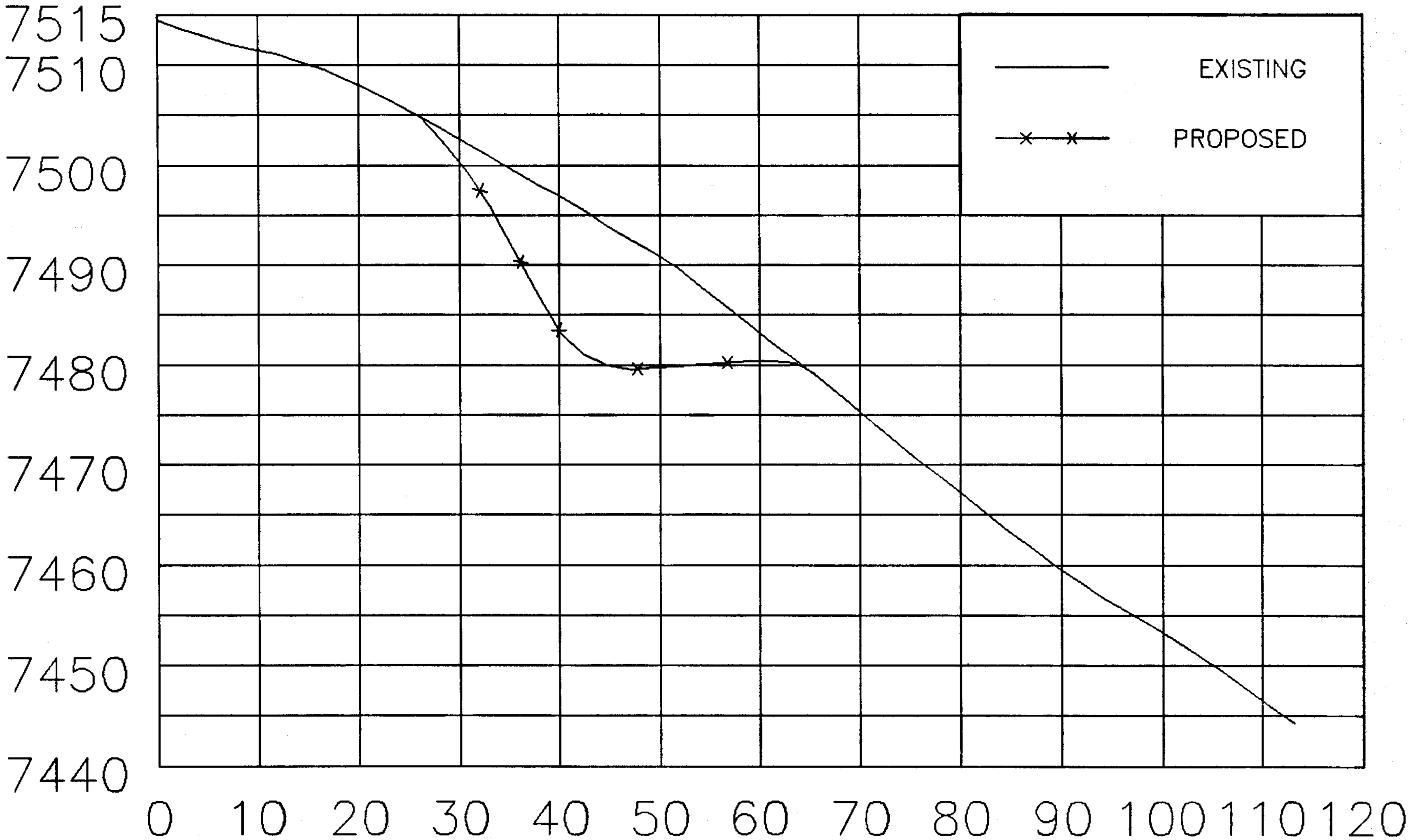
STATION 4+00



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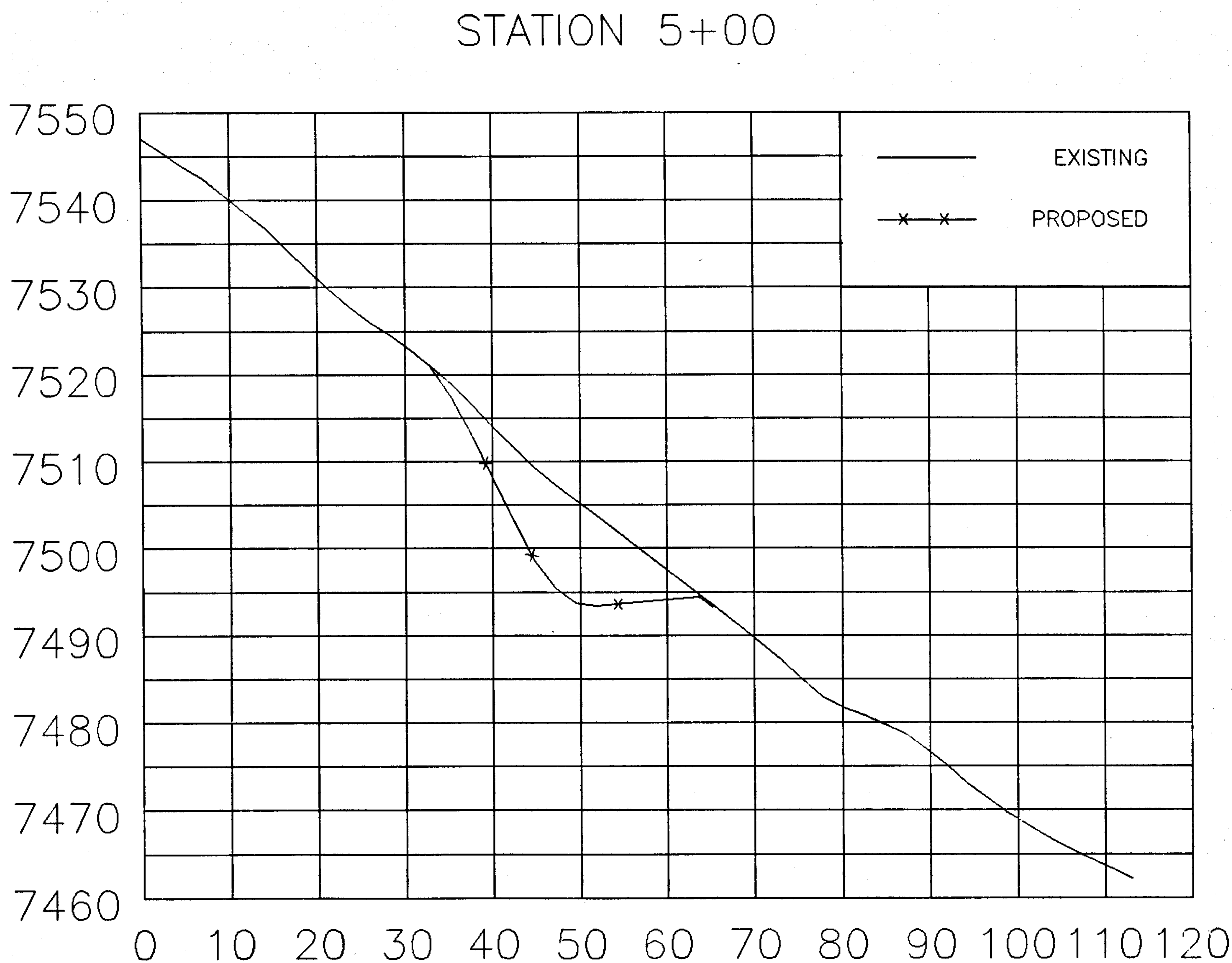
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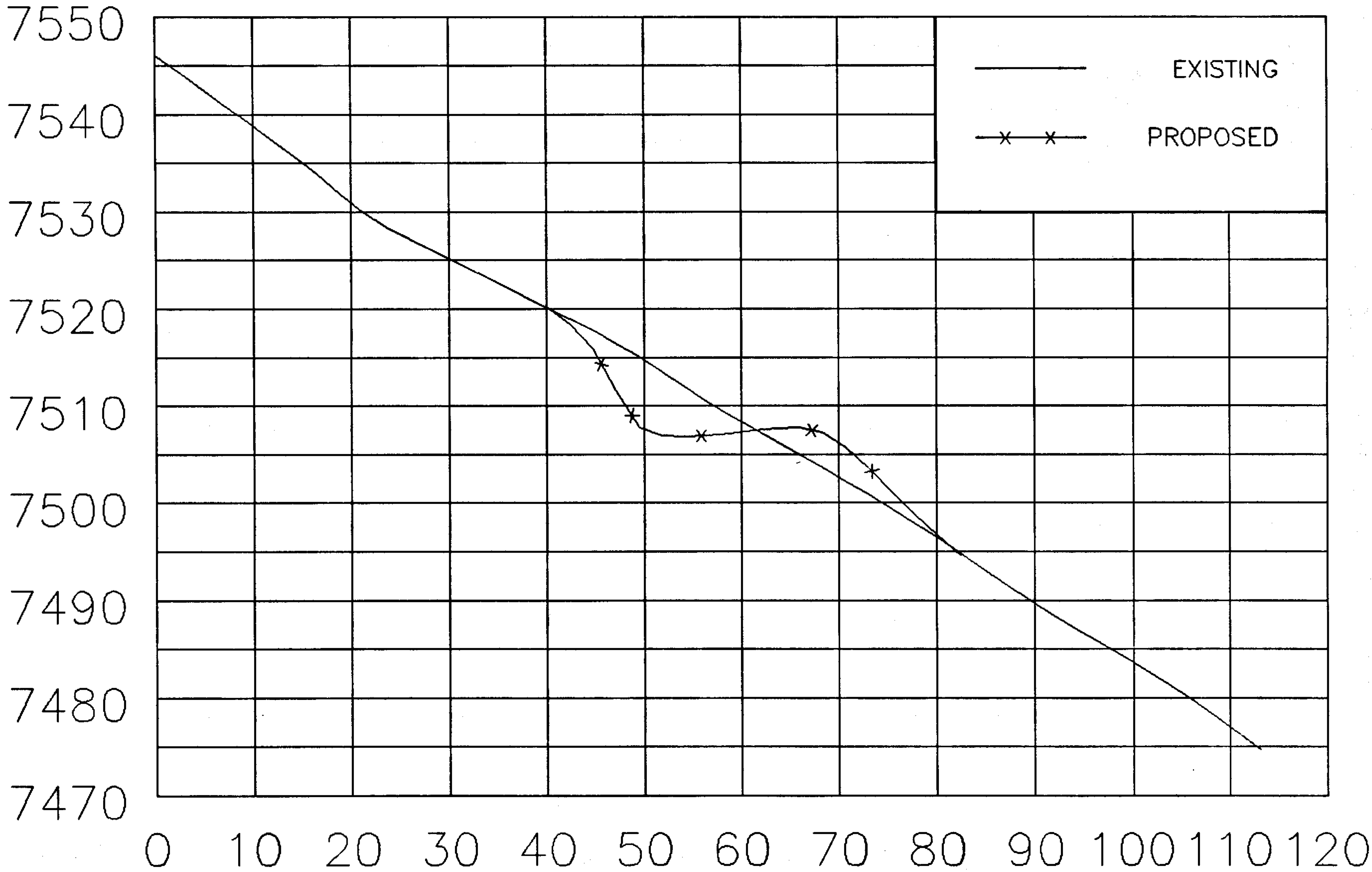

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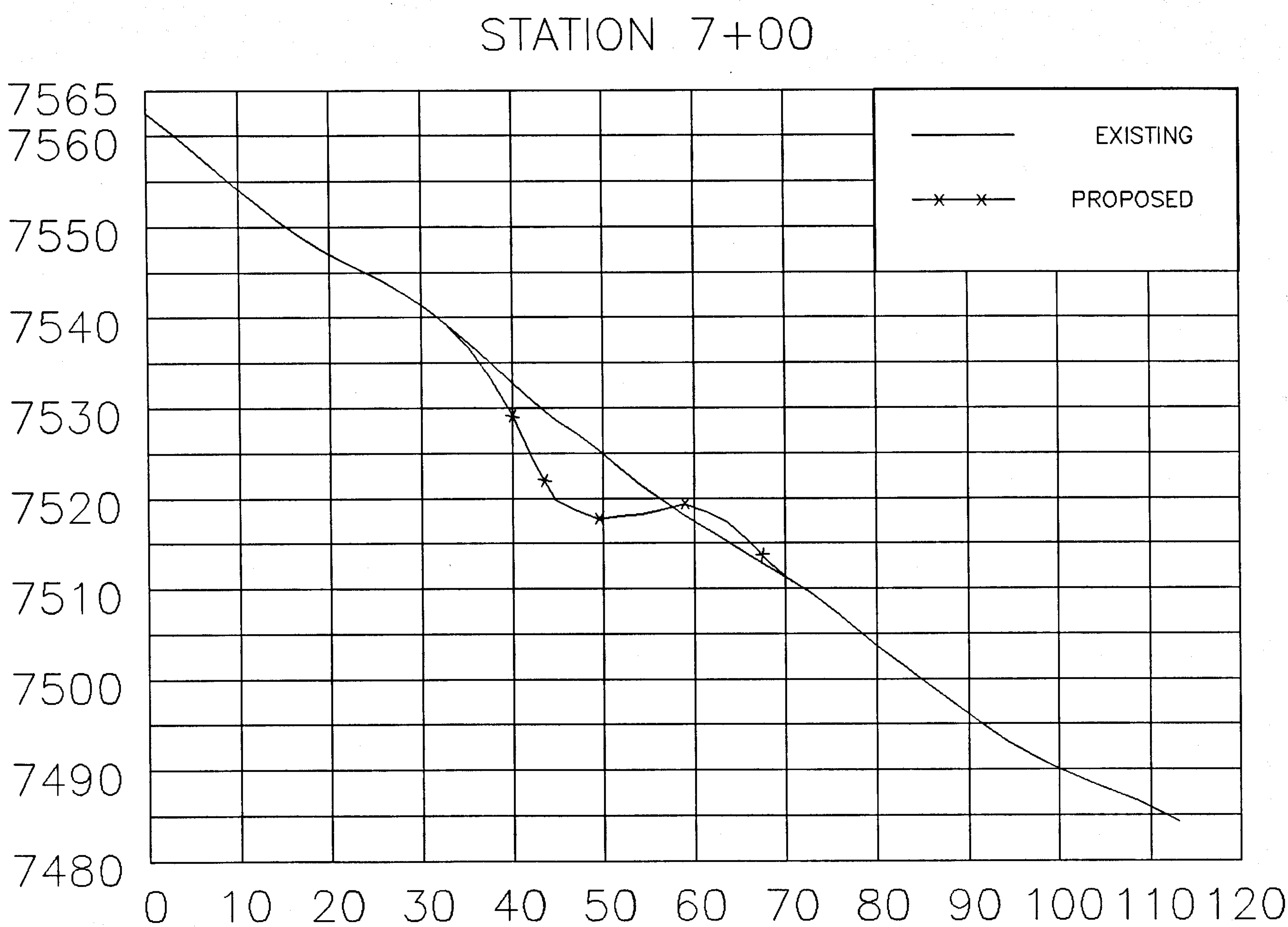

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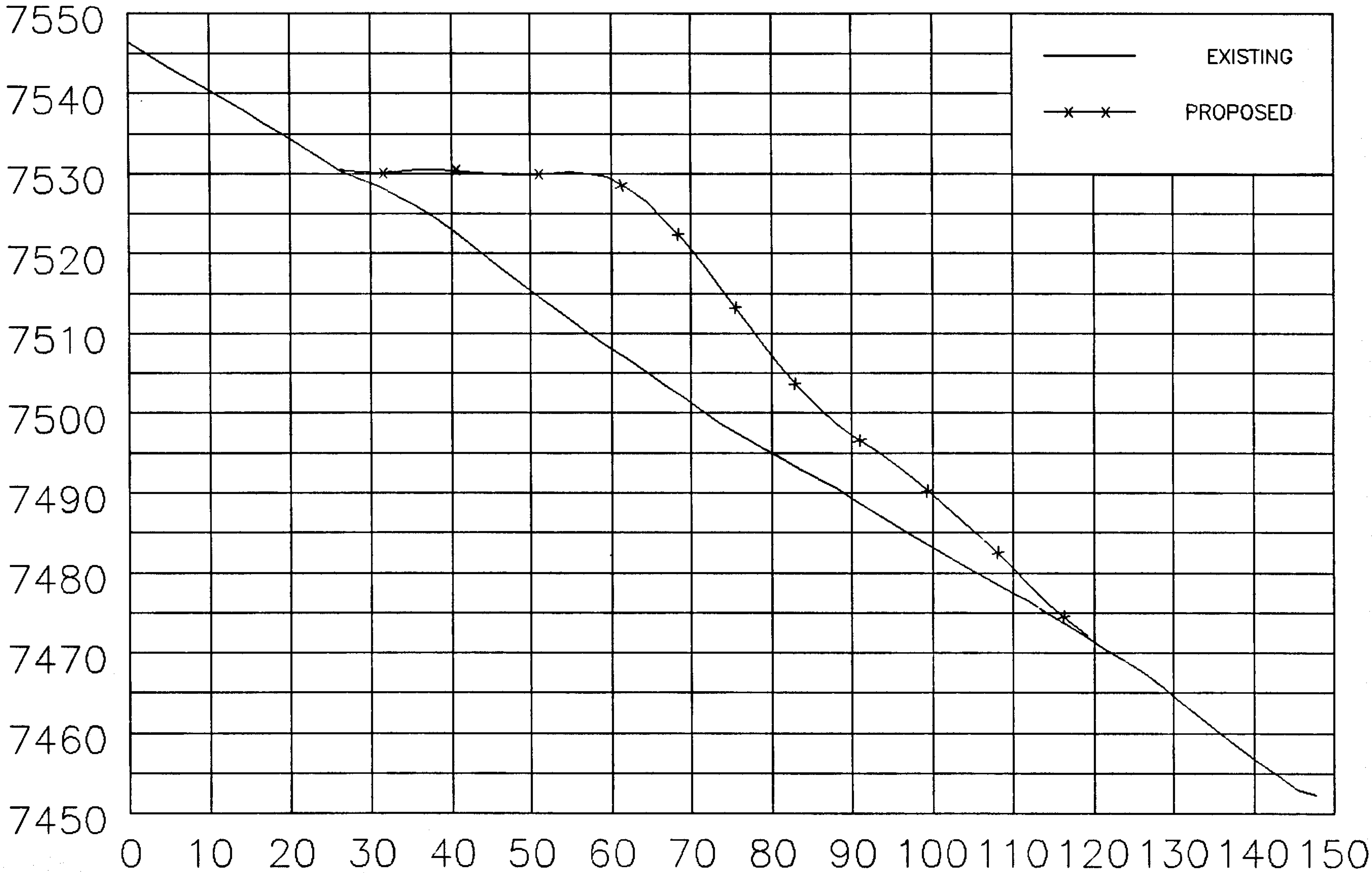

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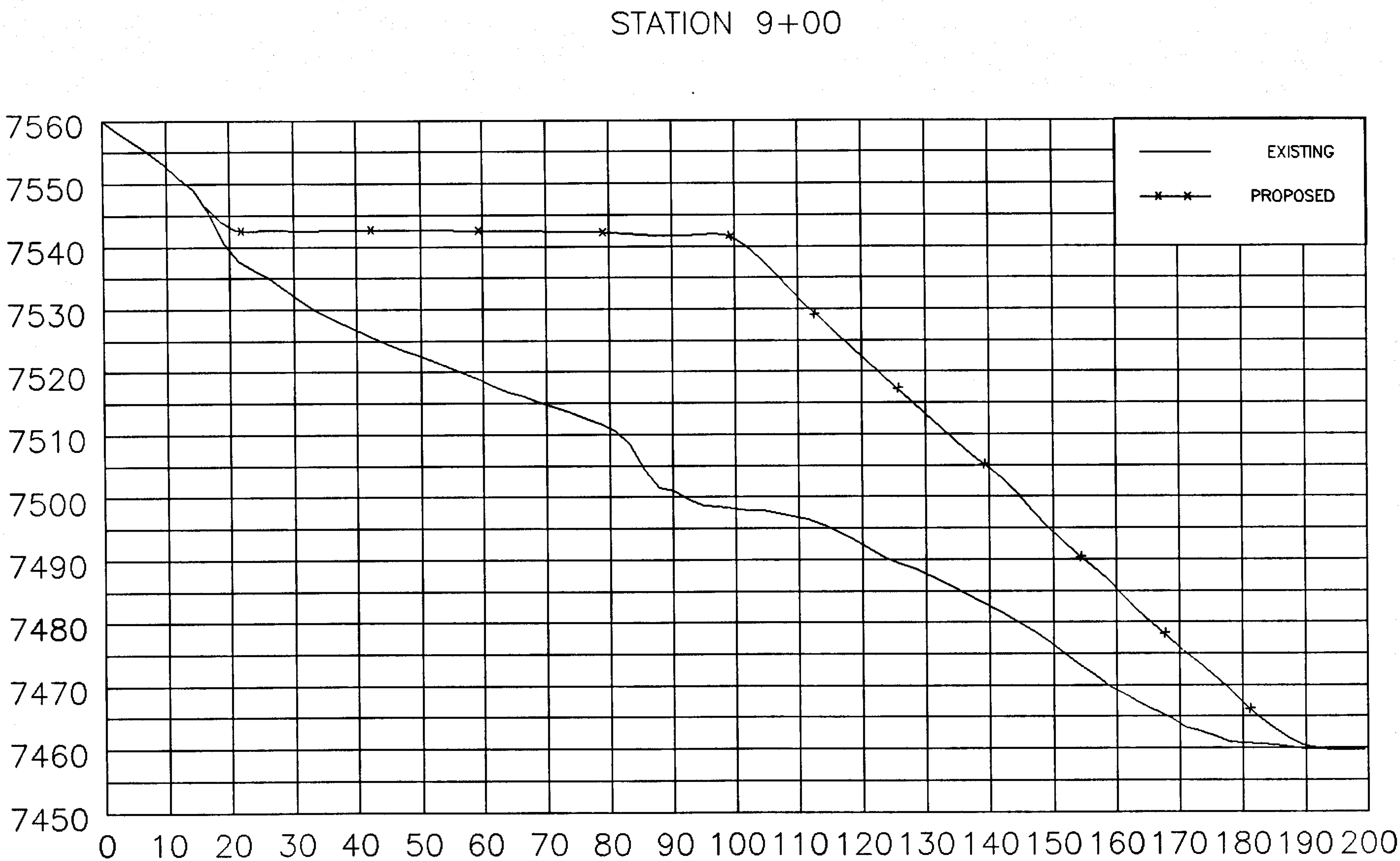
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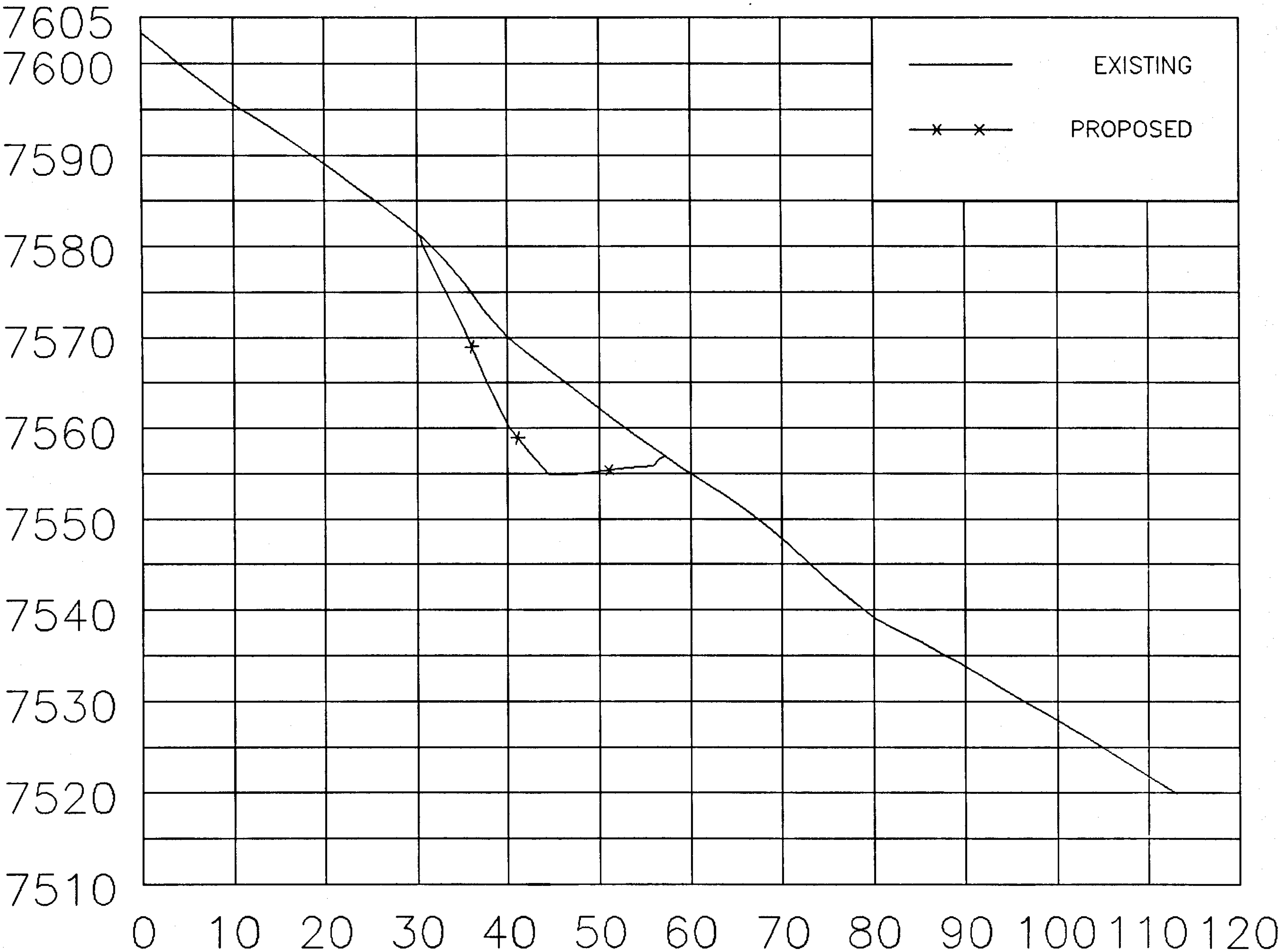

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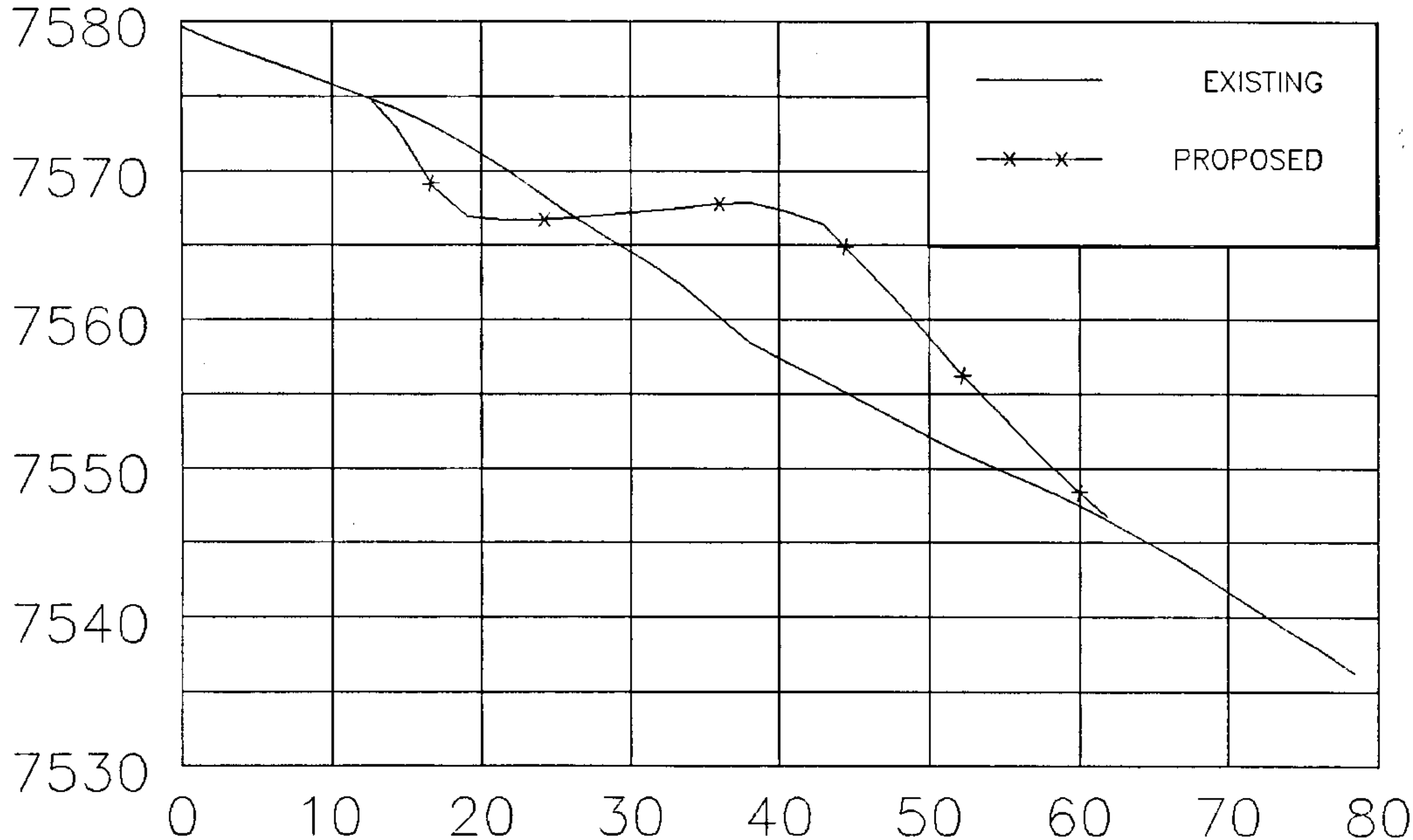

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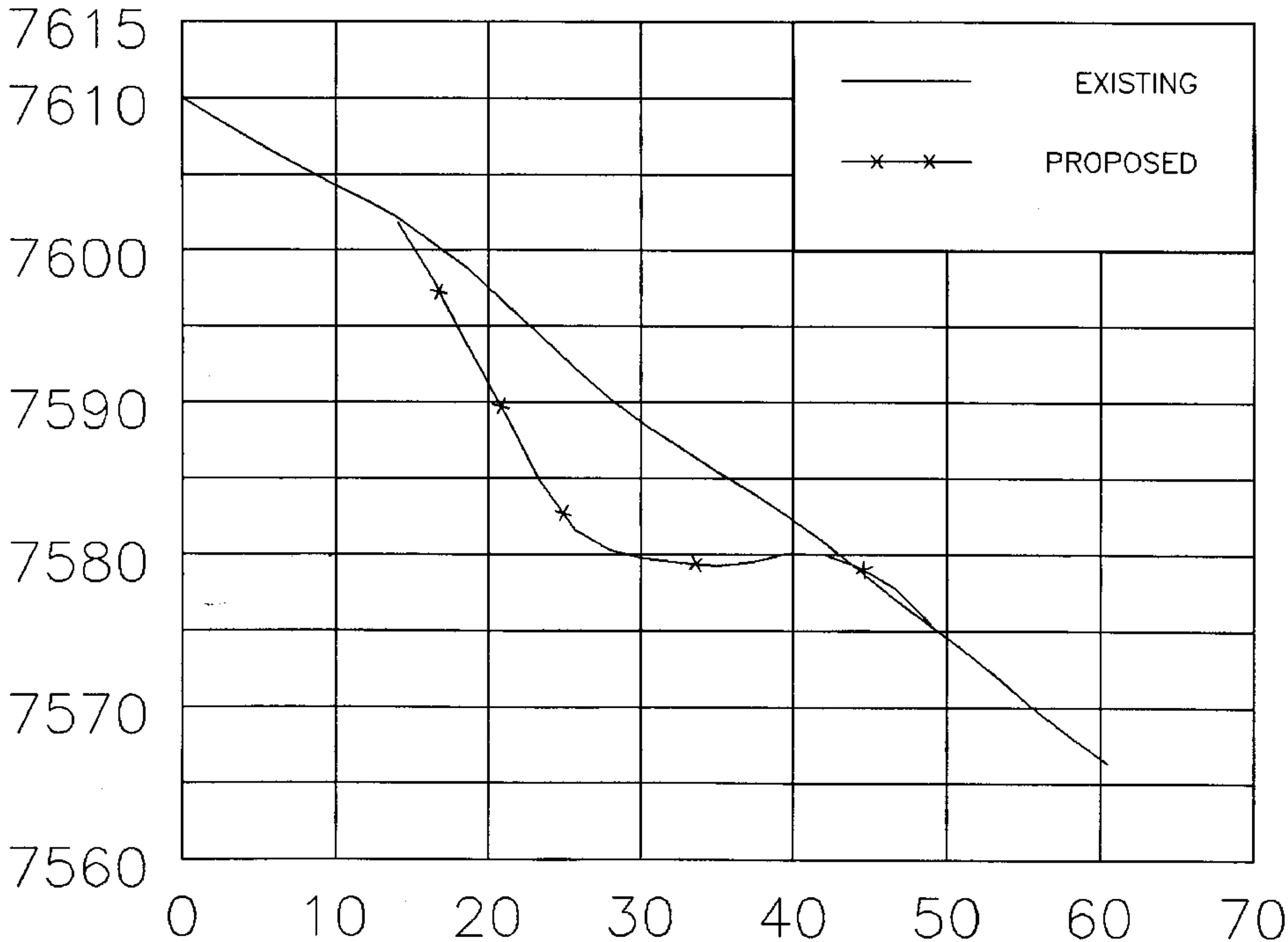

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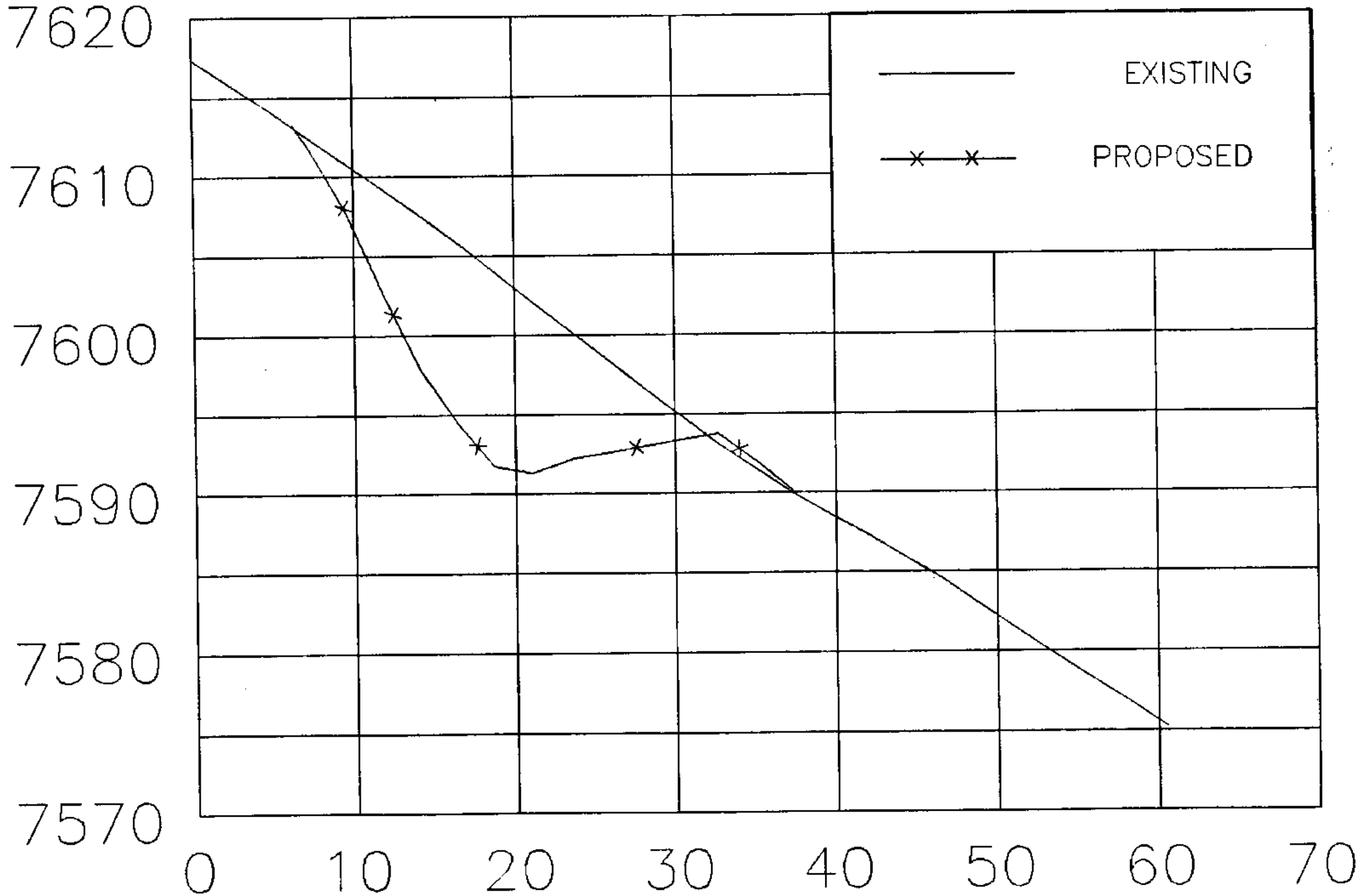

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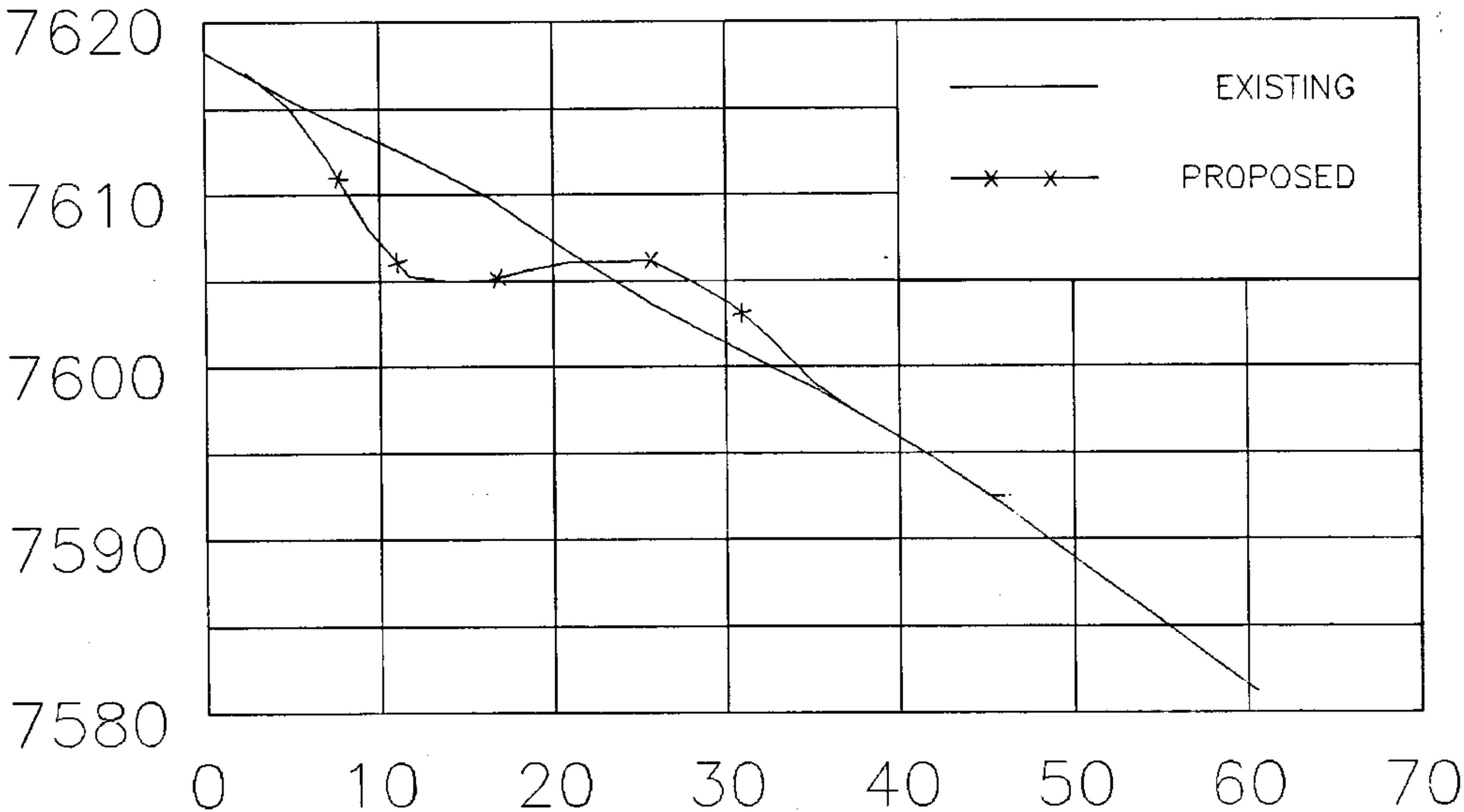

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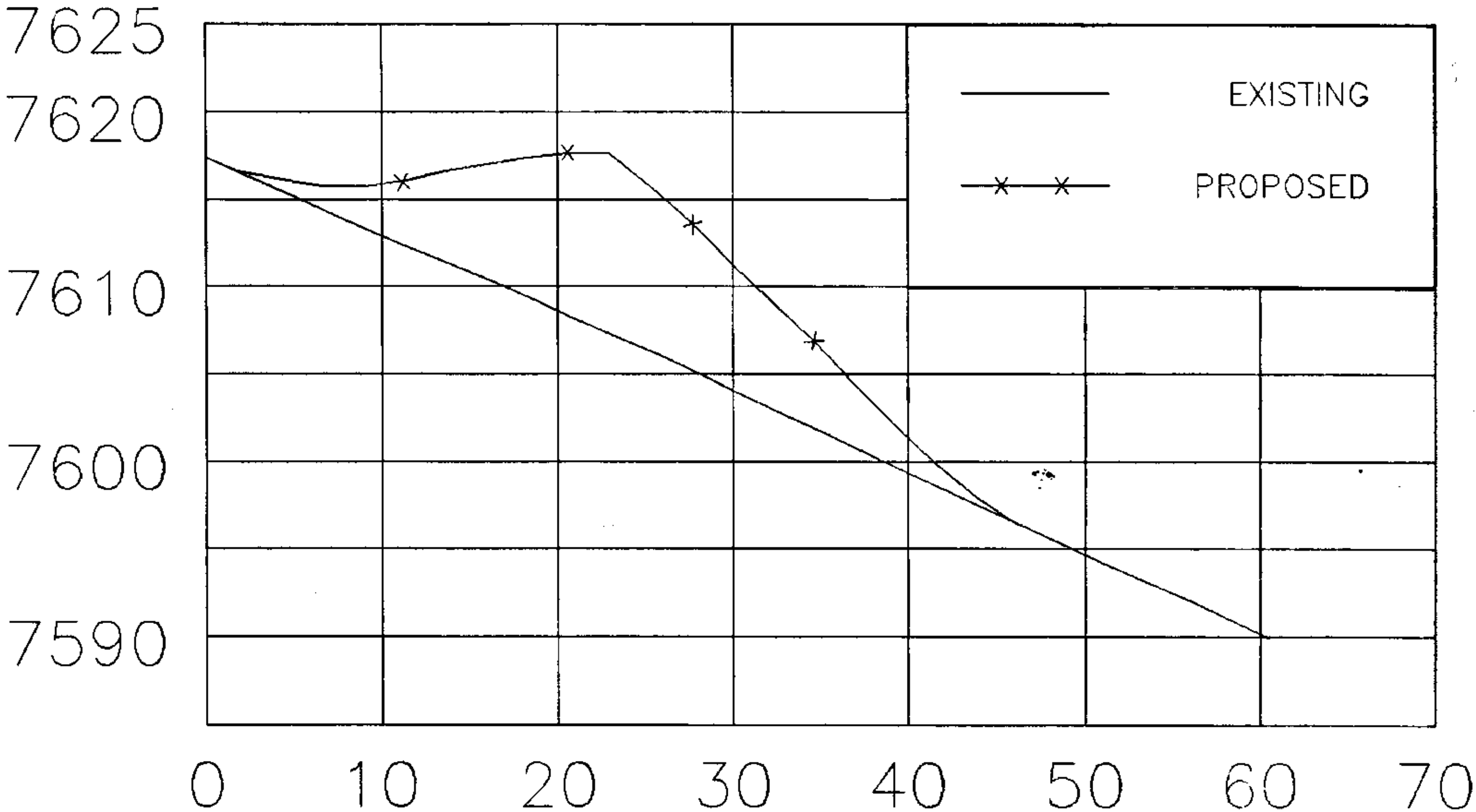

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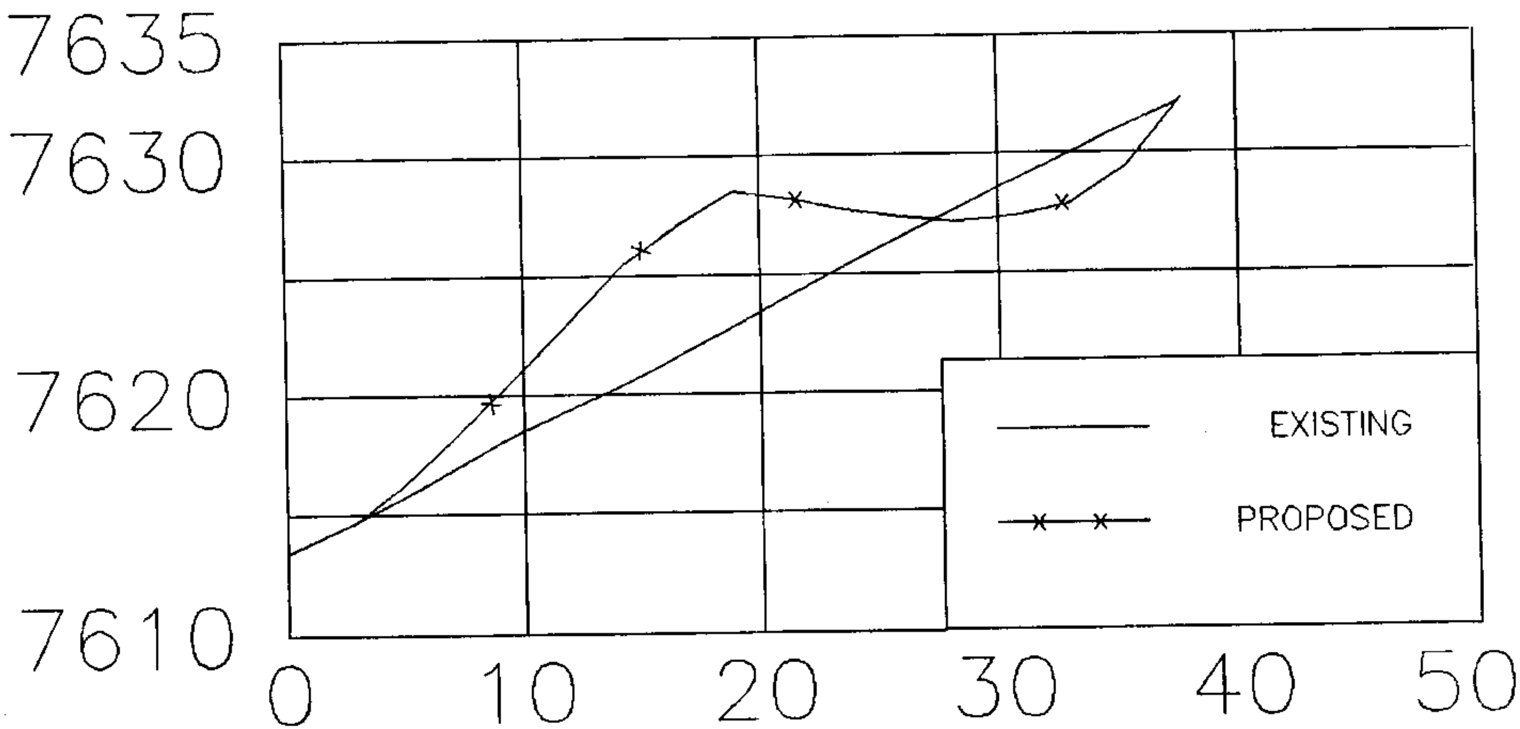

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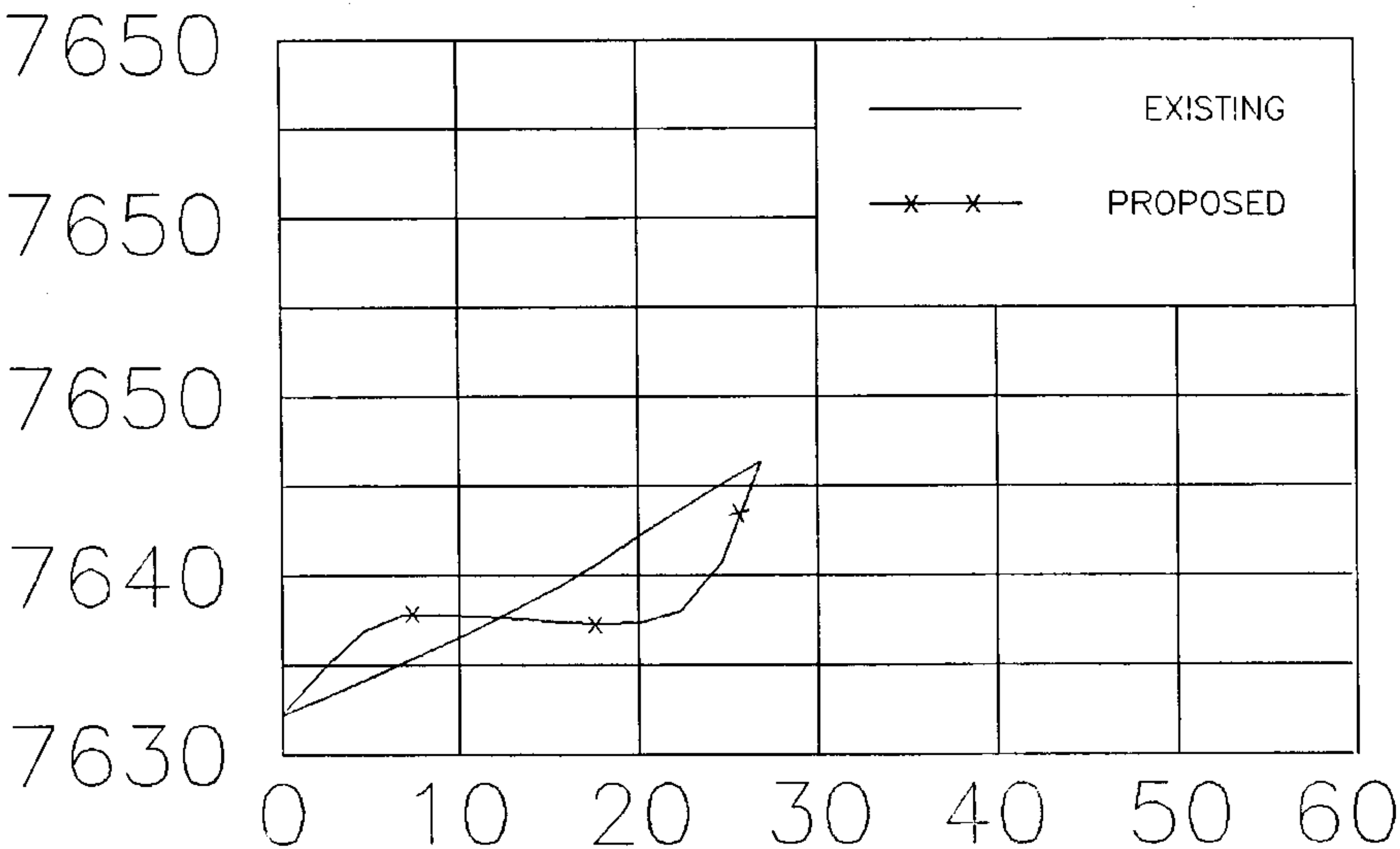

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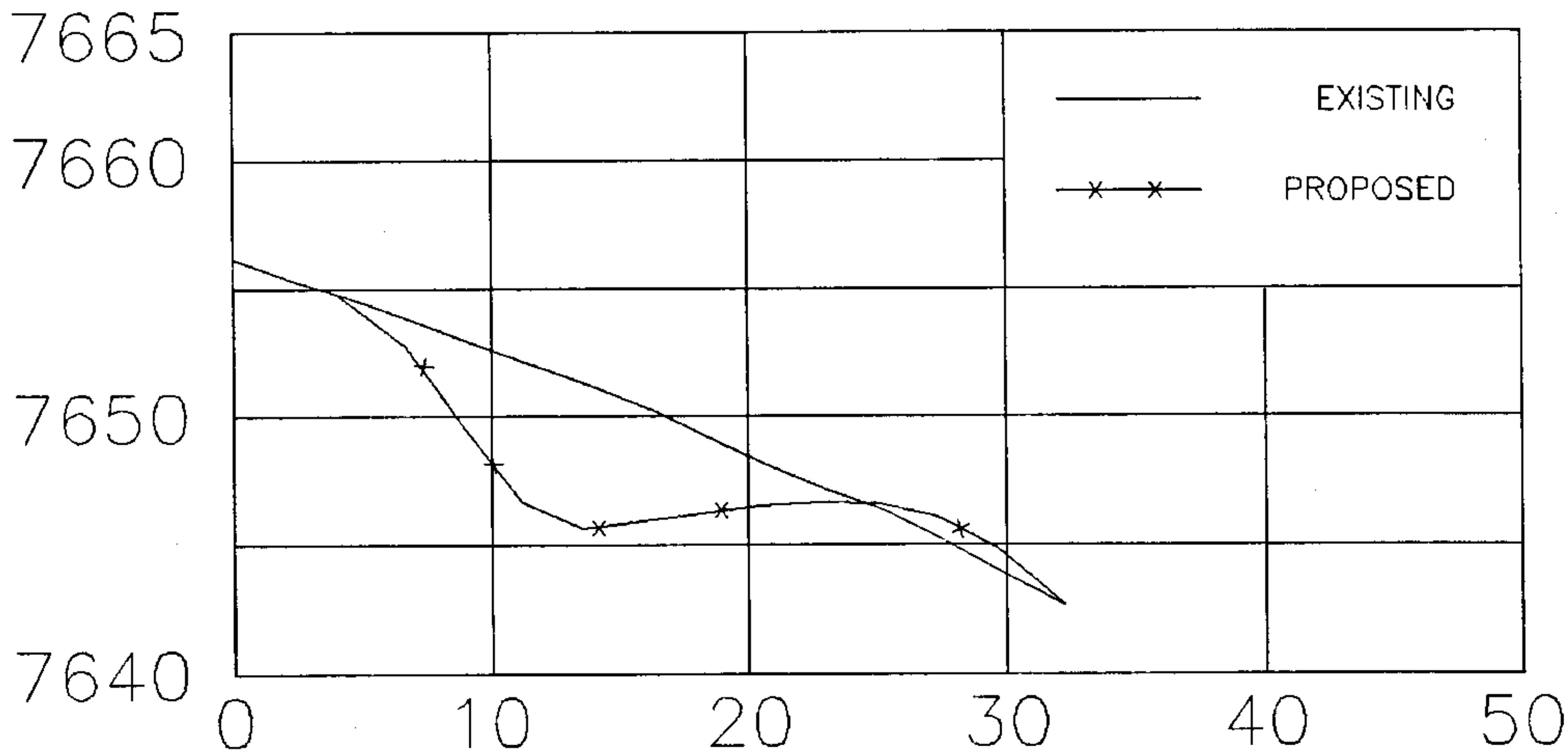

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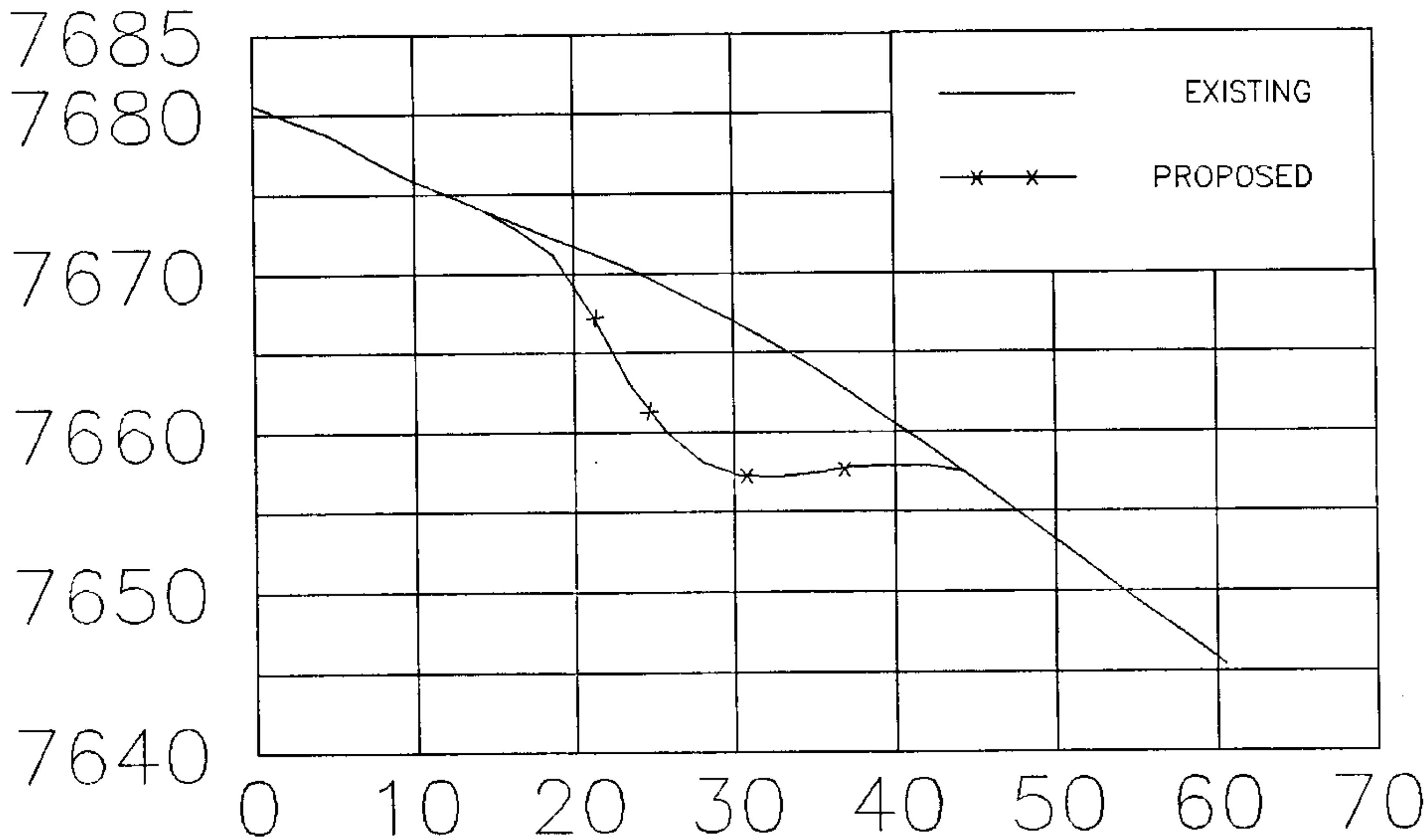

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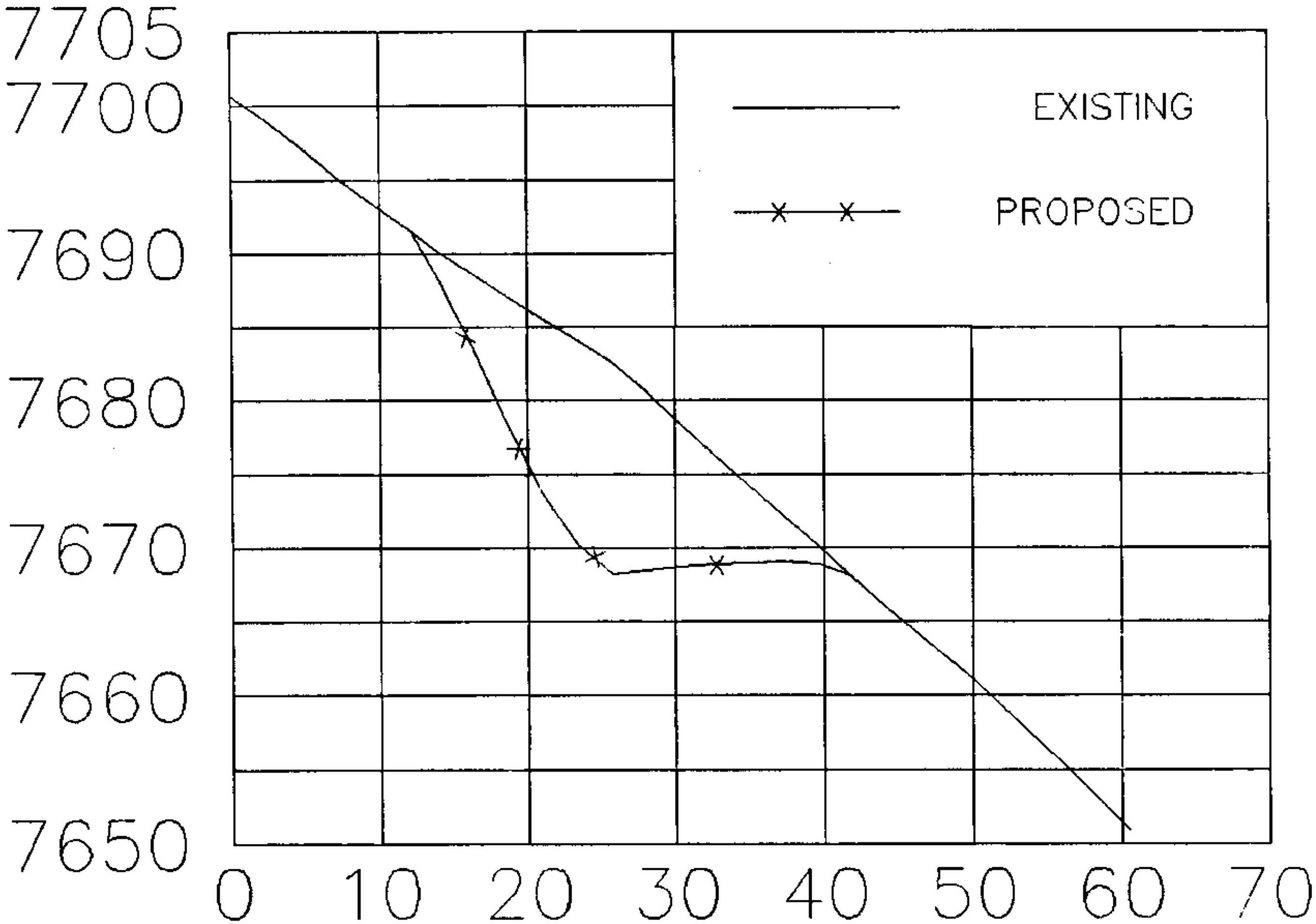

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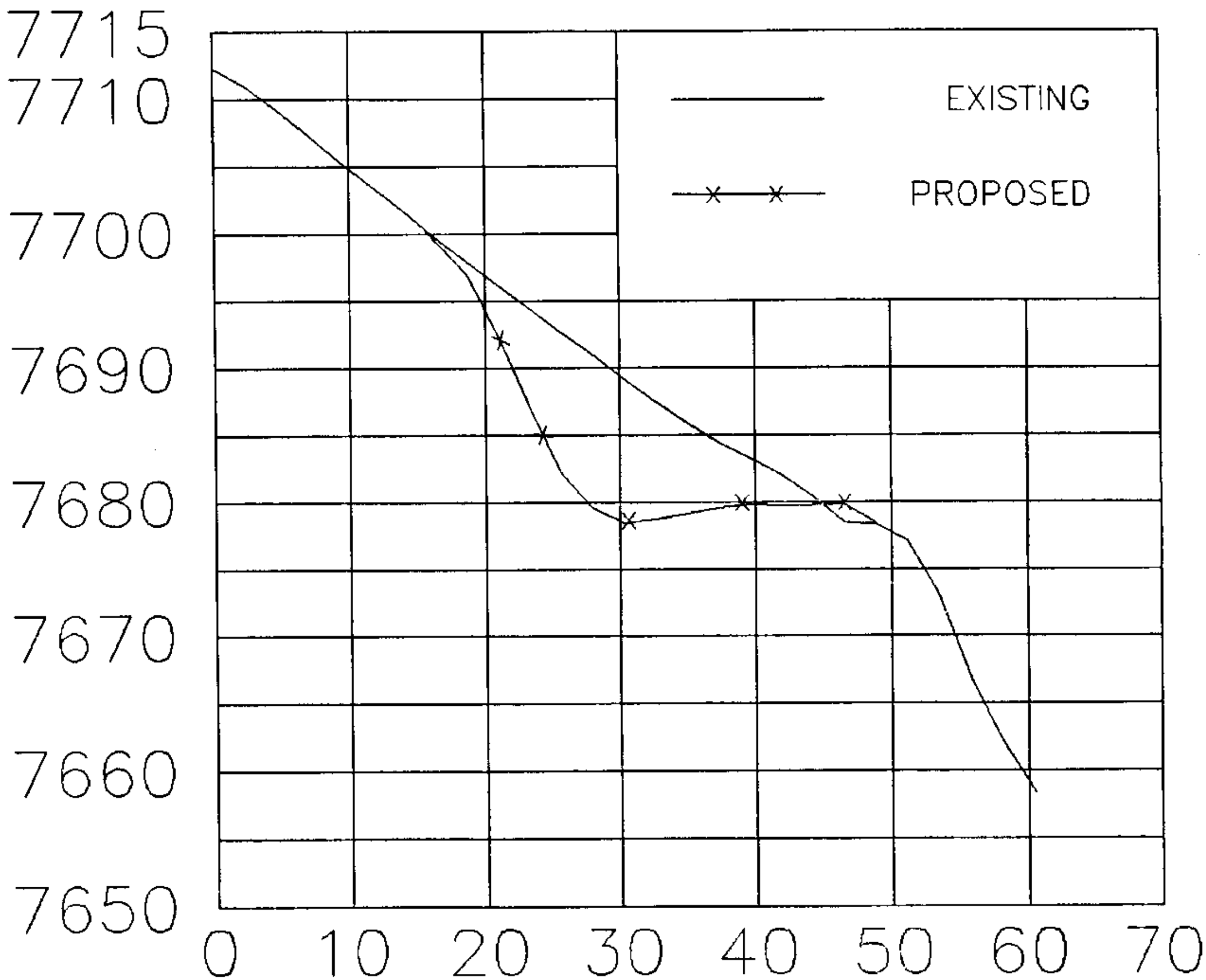

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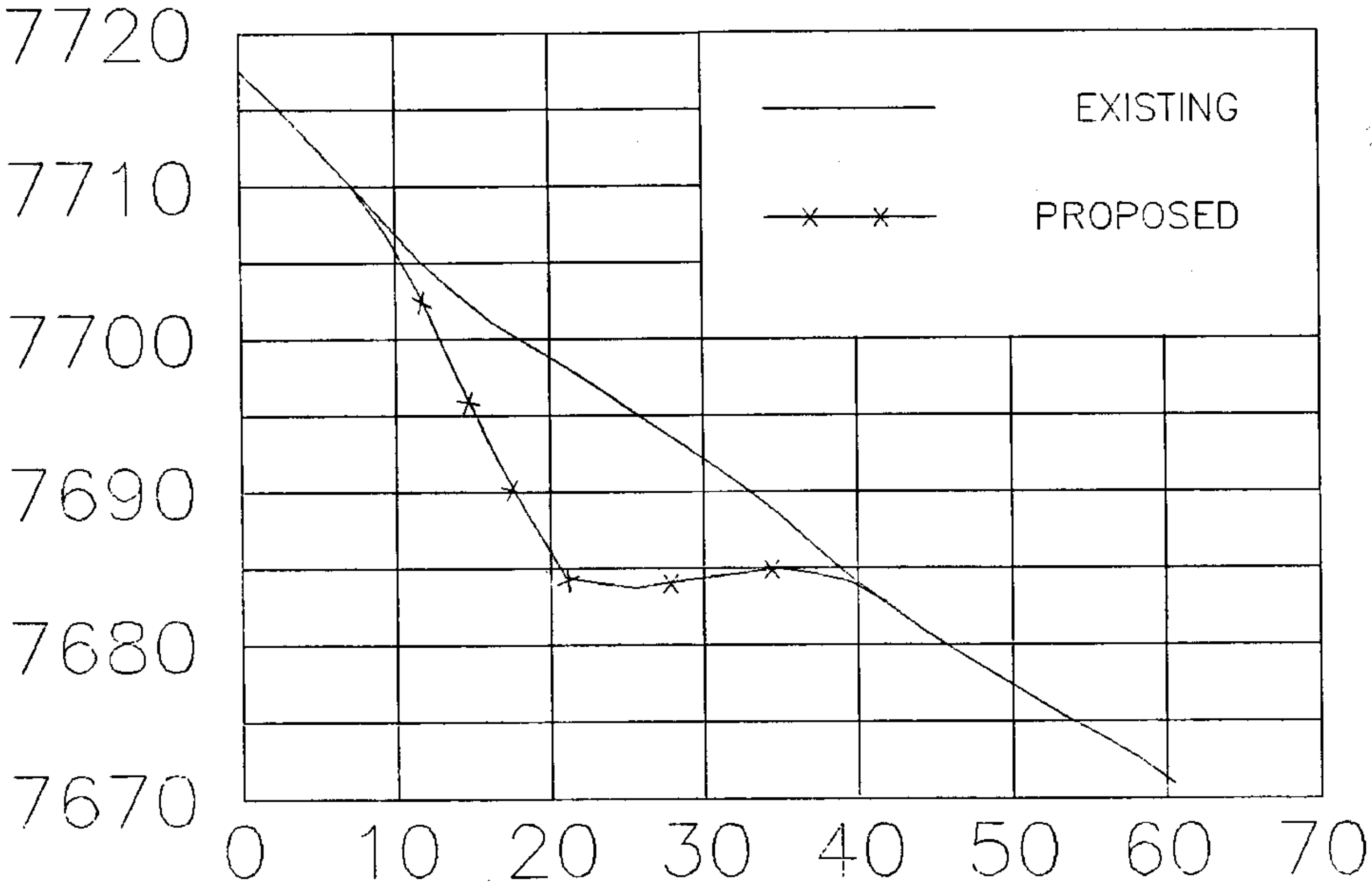

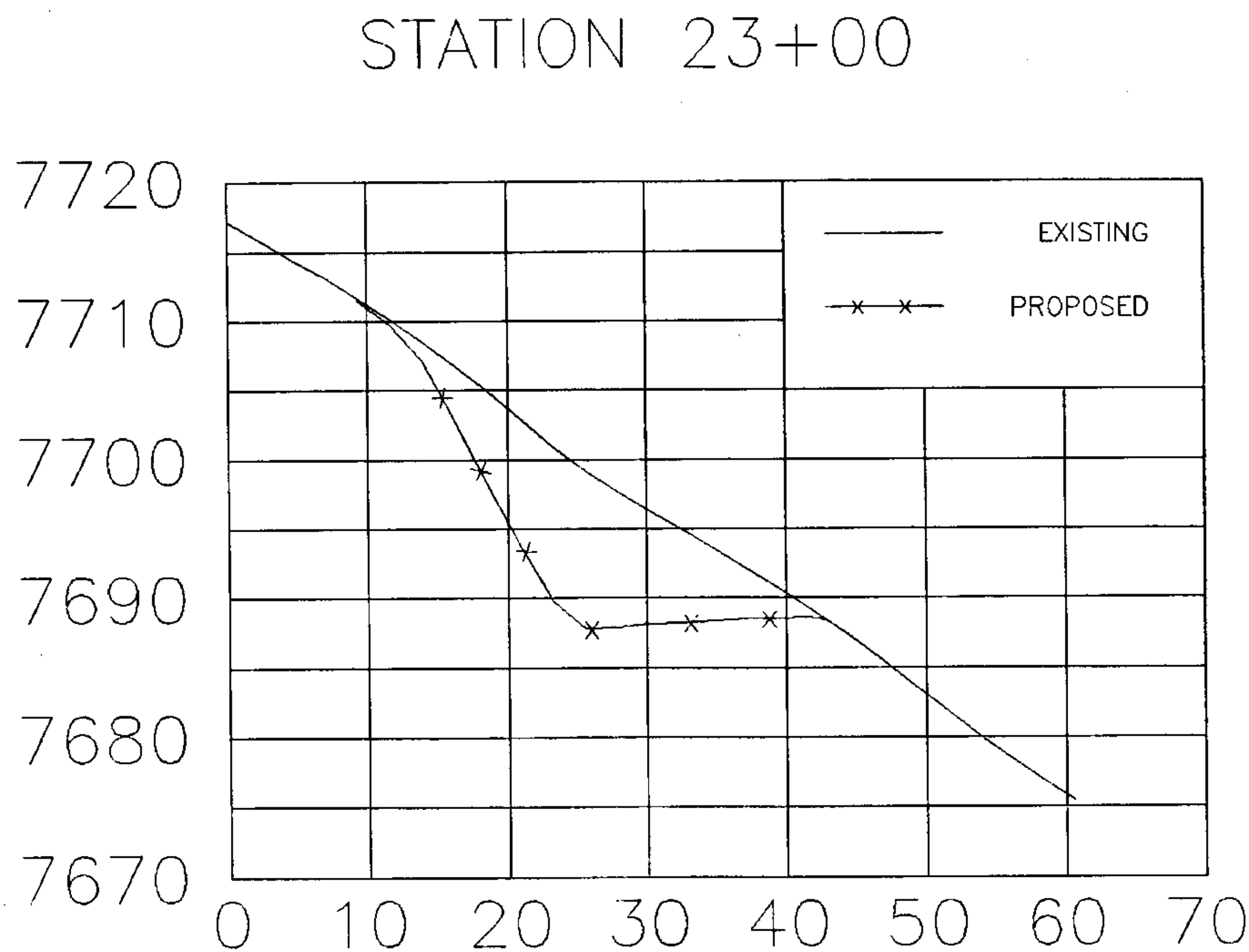

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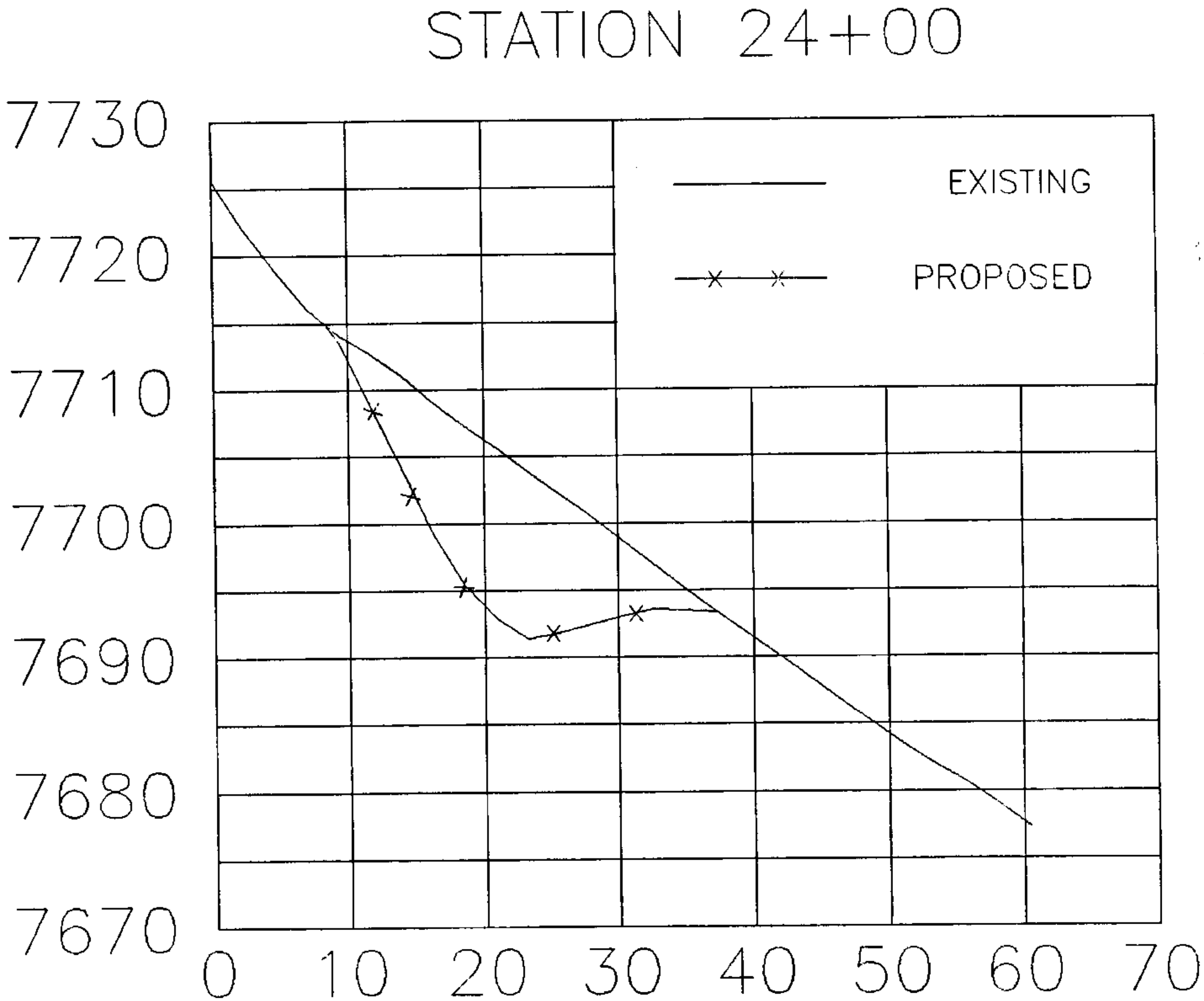
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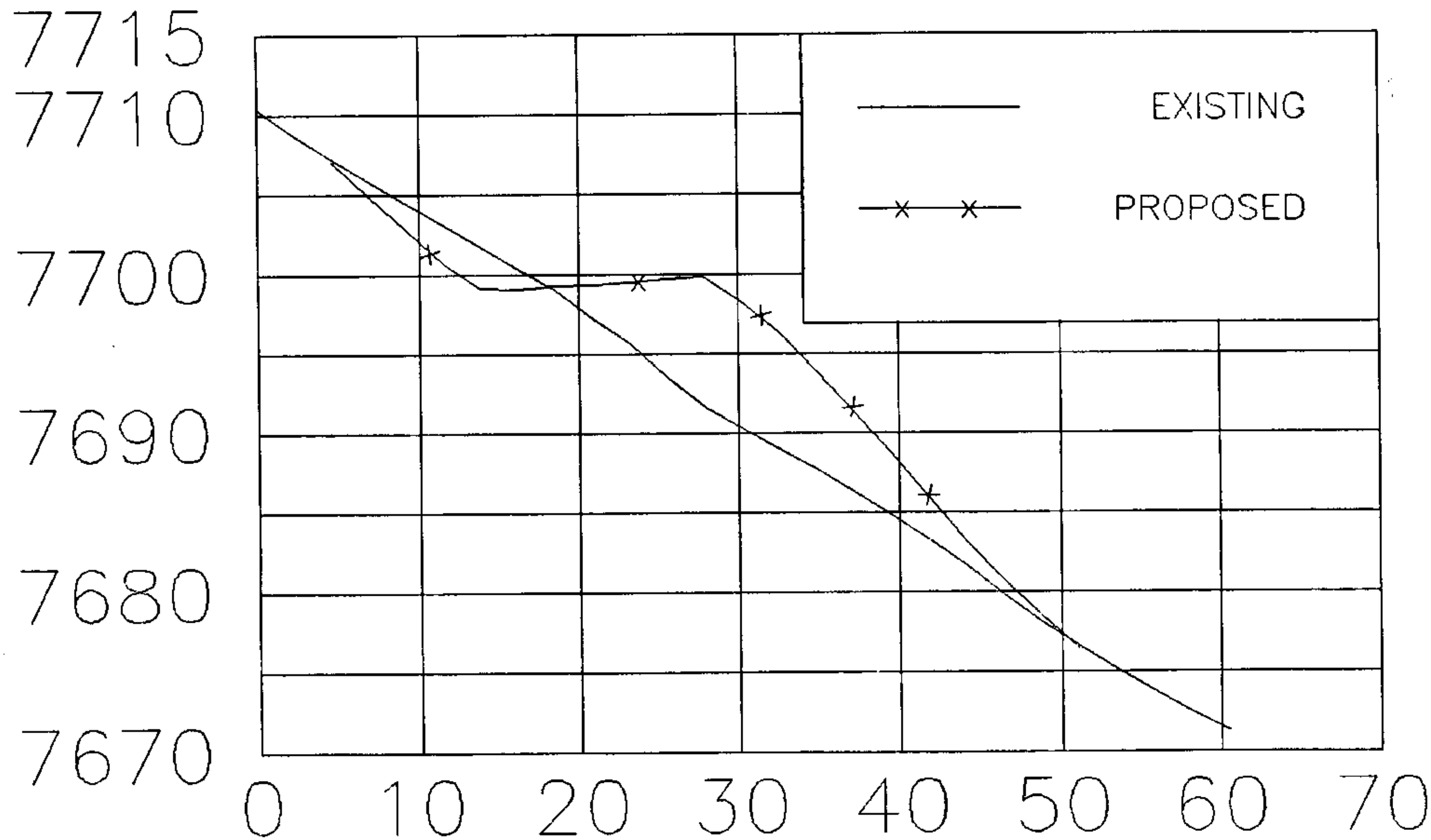

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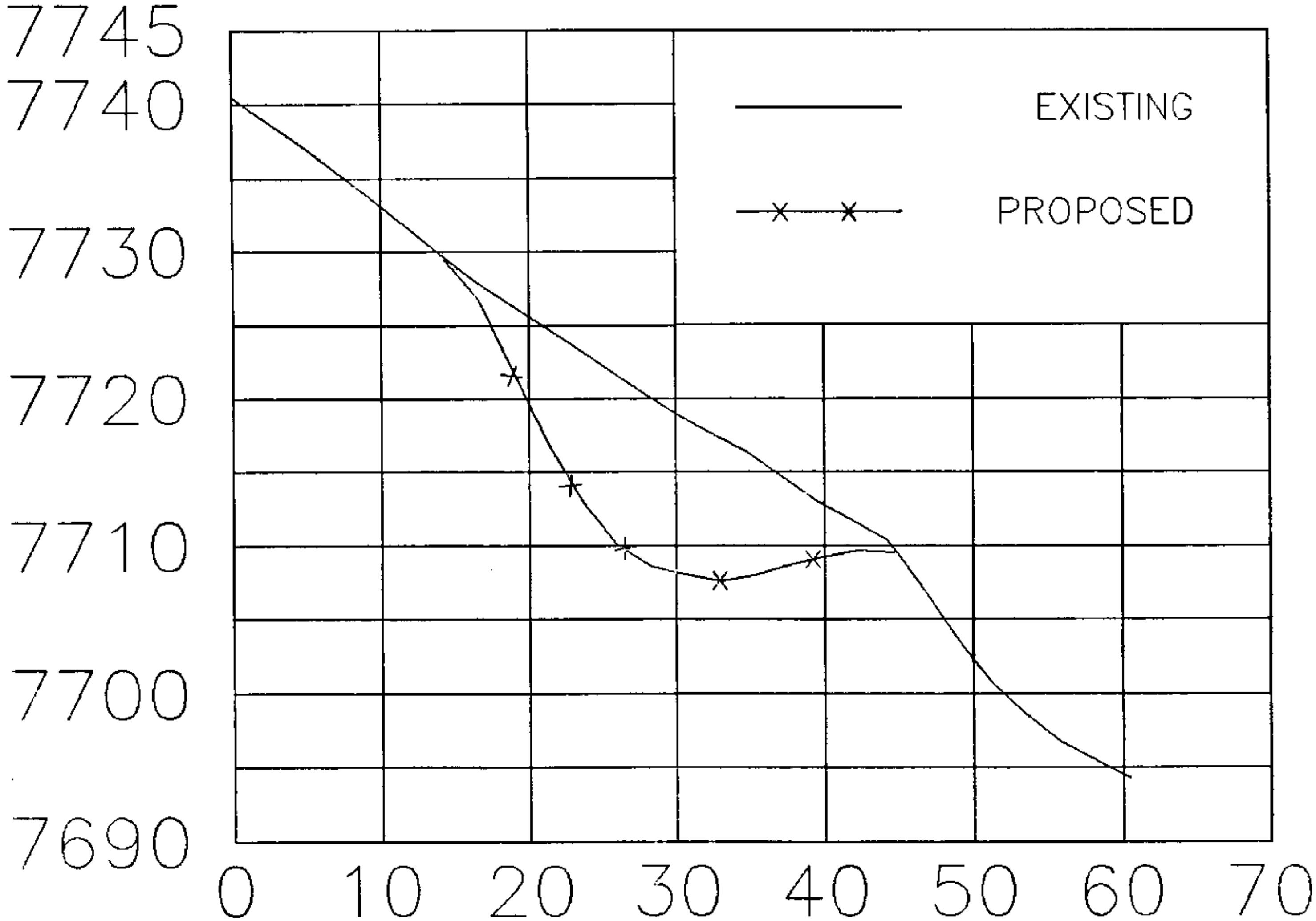

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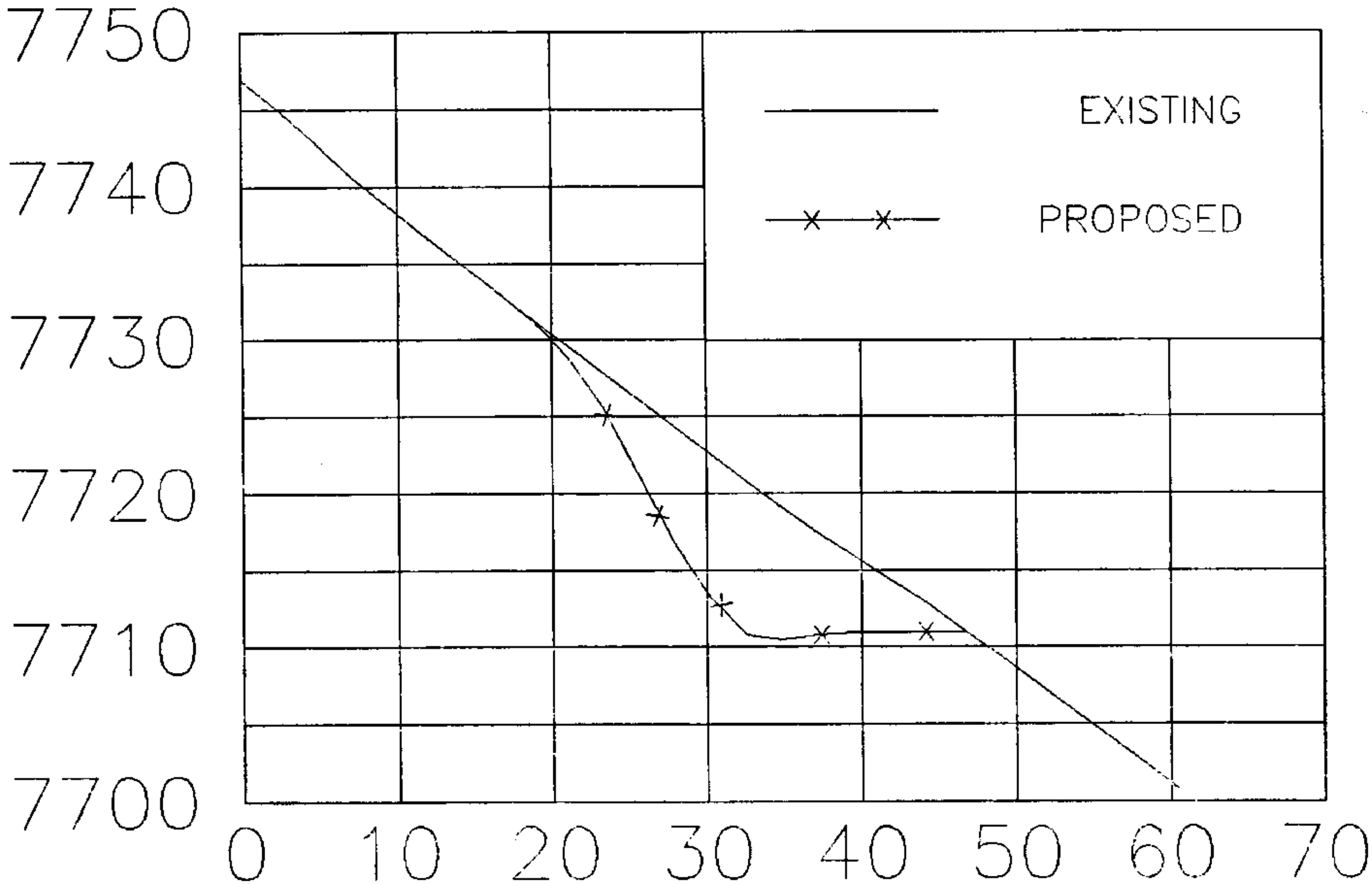

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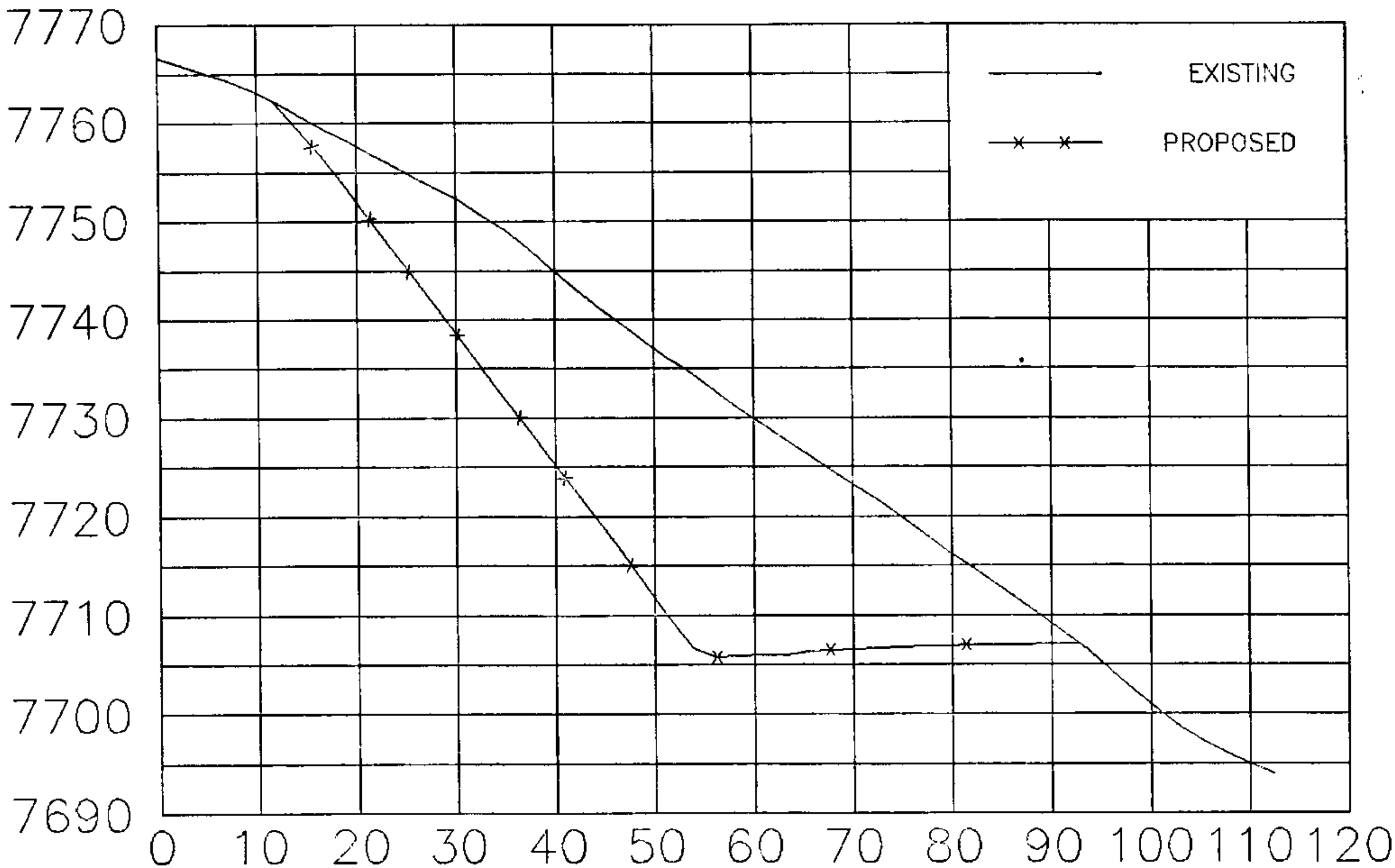

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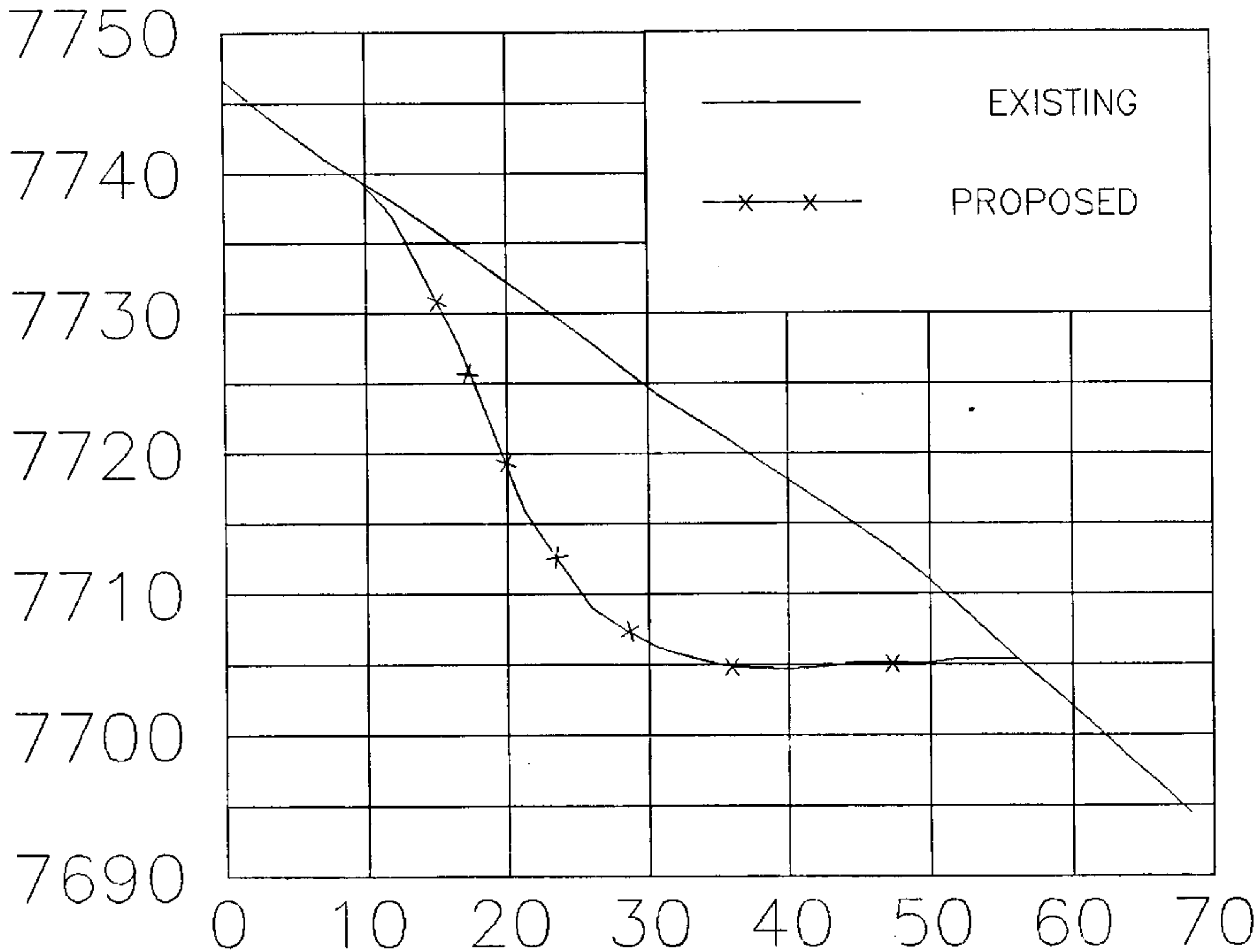

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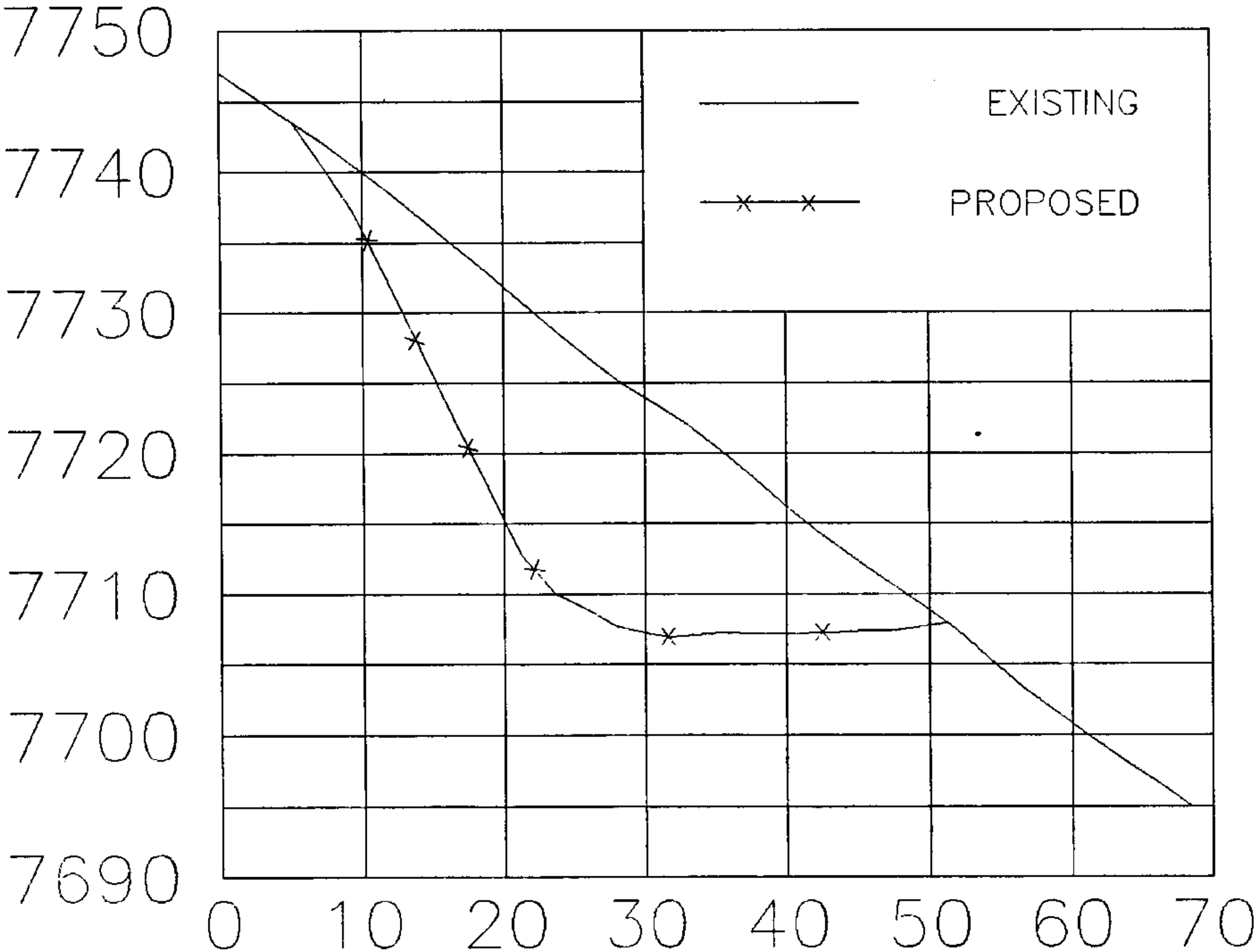


TANK SEAM ACCESS ROAD

SLOPE STABILITY ANALYSIS

DAMES & MOORE

127 SOUTH 500 EAST, SUITE 300, SALT LAKE CITY, UTAH 84102-1959
(801) 521-9255 FAX: (801) 521-0380

May 6, 1994

CO-OP Mining Company
P.O. Box 1245
Highway 31
Huntington Canyon
Huntington, Utah 84528

Attention: Mr. Charles Reynolds
Mining Engineer

Report
Geotechnical Consultation
Tank Seam Portal Access Road
Job No. 27437-001-162

INTRODUCTION

An initial report addressing the stability of the Tank Seam Portal Access Road, dated September 16, 1993 was previously sent to CO-OP Mining Company. Several initial concepts concerning road construction have been re-evaluated. This report updates the initial report and incorporates latest construction concepts.

CO-OP Mining Company proposes to construct an access road in Bear Creek Canyon to the Tank Coal Seam located at an elevation of approximately 7,720 feet. The general location of the proposed road relative to existing coal facilities is shown on Plate 1, Plot Plan.

On August 30, 1993, Wendell Owen and Charles Reynolds contacted Dames & Moore and requested that the design cut and fill slopes of the proposed extension of the existing access road at the Bear Creek Mine be evaluated. CO-OP Mining Company plans to commence underground mining of the Tank Seam which is above the Bear Creek Seam currently being mined. On September 2, 1993, an engineering geologist from the Salt Lake City office of Dames & Moore made a reconnaissance of the proposed access road alignment accompanied by Charles Reynolds, Project Mining Engineer for CO-OP Mining Company. Observations and recommendations resulting from that reconnaissance and subsequent analyses are presented in this report.

BACKGROUND

CO-OP Mining Company is in the process of expanding its underground coal mining operation and proposes to mine the Tank Coal Seam approximately 300 feet above the Bear Creek Seam currently being mined. To access the Tank Seam, CO-OP Mining Company proposes to extend the existing access road from the Bear Creek Portal, at elevation 7,440 feet, to the Tank Seam portal area, at an elevation of approximately 7,720 feet.

An engineering geologist and a geotechnical engineer from Dames & Moore visited the site in 1980 and performed a reconnaissance survey of the area prior to the construction of the Bear Creek Portal access road. That road was built with cut slopes in rocky slope wash (colluvium) using side-cast construction. The road has been serviceable with little or no maintenance problems since construction was completed. Two letter reports addressing the Bear Creek Portal Access Road cut and fill stability were provided to CO-OP Mining Company, dated December 29, 1980 and February 20, 1981.

The proposed access road to the Tank Seam Portal is expected to be 14 feet wide with a drainage ditch and safety berm. The total width may approach 20 feet. Planned construction is expected to be achieved through cut and fill methods.

SITE CONDITIONS

The general location of the Tank Seam Portal Access Road is shown on Plate 1, Plot Plan. The access road will be constructed by cut and fill methods. The average natural slope angle of the slopes across which the Tank Seam access road must traverse is approximately 35 degrees. The majority of material to be excavated is expected to consist of fine to coarse gravel, cobble, and boulder sized pieces of sandstone in a matrix of sand and clayey silt. This material generally has a slight to medium dry strength due in part to the presence of calcium carbonate cementation. Some natural slopes in this material are standing vertically up to a height of 15 feet.

Bedrock of moderately hard to hard, fine to medium grained, bedded sandstone is present as scattered outcrops throughout the slope. Most of the outcrops form prominent near horizontal ledges on the slopes. Vertical joints form boulder sized blocks in the bedrock which in turn produce angular boulder and cobble sized rock fragments that are scattered across the slope surface. Occasional juniper and pinon pine trees as well as sage brush and other large shrubs comprise the majority of vegetation on the slopes.

SOIL CONDITIONS

During the reconnaissance of the Tank Seam Portal Access Road, two soil samples were obtained to determine the engineering properties of the soil. The approximate locations where the soil samples were taken are shown on Plate 1, Plot Plan. The results of a partial grain size analysis are tabulated below:

SAMPLE NO.	SIEVE NO.	PERCENT FINER BY WEIGHT
1	# 4	91.6
	# 10	74.4
	# 40	62.7
	#200	27.1

SAMPLE NO.	SIEVE NO.	PERCENT FINER BY WEIGHT
2	# 4	74.0
	# 10	65.8
	# 40	55.3
	#200	37.0

Results of Atterberg limits tests performed on material finer than the number 200 sieve for both samples are tabulated below:

SAMPLE NO.	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX	UNIFIED SOIL CLASSIFICATION
1	24	19	5	CL-ML
2	22	16	6	CL-ML

These tests indicate that the finer fraction of the natural soil in the area is more silty than the soil tested previously during construction of the Bear Creek Portal Access Road.

Consolidated drained direct shear tests were performed on remolded portions of these two samples. The average strength values obtained from the direct shear tests indicate an effective stress friction angle of 32 degrees and a cohesion value of 180 psf. These soil properties were utilized in the subsequent slope stability analyses for both the cut slopes and the major fill slopes.

SLOPE STABILITY ANALYSIS

An analysis of the stability of proposed cut slopes and fill sections was performed utilizing a two dimensional, limit equilibrium stability program called PCSTABL5. For the cut slope evaluation, an automatic search routine was employed to determine the failure surfaces with the lowest factors of safety. Both random and circular failure surfaces were evaluated. For the fill section, a specified failure surface was input to represent the critical failure surface. For both analyses, a natural slope of 35 degrees was modeled considering dry conditions.

The analyses of the cut slope section considered vertical cuts, one horizontal to four vertical (1H:4V) cuts, and one horizontal to two vertical (1H:2V) cuts. Bedrock was conservatively modeled to be present 6 feet vertically below the ground surface and to trend parallel to the natural cut. The depth to bedrock along the Tank Seam Access Road is realistically expected to vary from exposures at the ground surface to depths of 2 to 3 feet. From a constructability standpoint, a 1H:2V cut configuration was determined to be the most stable. Plate 2 presents the configuration modeled, the input material properties, and the ten failure surfaces with the minimum safety factors. A minimum factor of safety of 1.4 was determined for the input configuration. The "arrows" on Plate 2 indicate the failure surface with the lowest safety factor.

The analyses of the fill section modeled an access road entirely constructed on fill. The fill slope was input with a 1H:1V slope and a specified failure surface was evaluated. Plate 3 presents the slope configuration, input properties, and the minimum safety factor. The natural slope was modeled as a plane surface, however, in reality this surface would be stepped due to occasional bedrock outcrops, and the factor of safety may actually be somewhat higher than portrayed.

CONCLUSIONS AND RECOMMENDATIONS

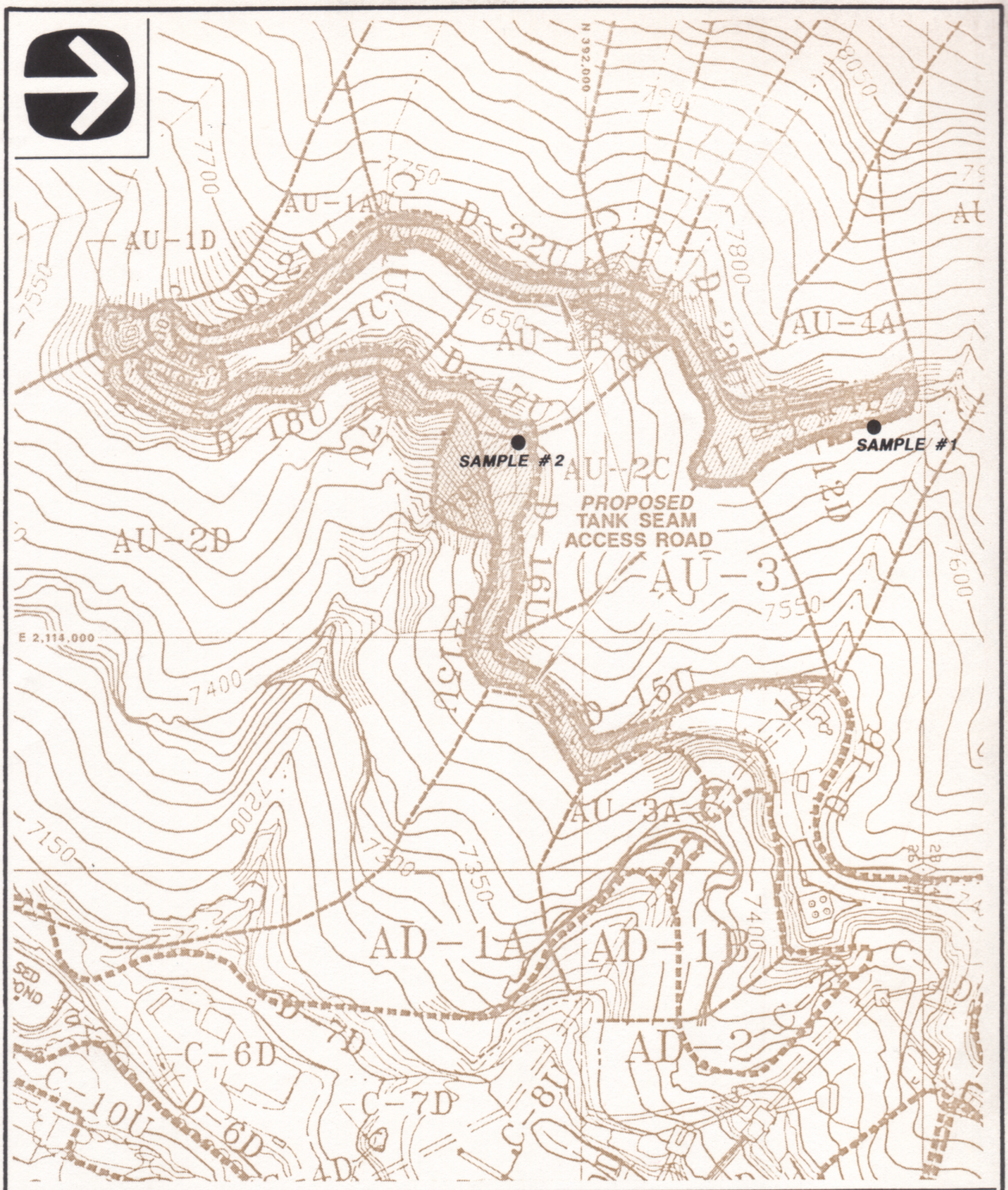
It is our understanding, from a telephone conversation with Charles Reynolds, that a minimum factor of safety required for cut and fill slopes along the access road is 1.3. The computer analysis for cut slope stability indicates a minimum static factor of safety of 1.4 for a slope of 1H:2V, or a slope angle of approximately 63 degrees. In the stability analysis we conservatively assumed a depth to bedrock of 6 feet. The depth to bedrock along the Tank Seam Access Road alignment will probably vary from exposures at the ground surface to depths of 2 to 3 feet. Only in the larger gullies, where the road will be mostly or entirely on fill, will the depth to bedrock exceed the assumed average of 6 feet. The effect of the calcium carbonate cementation in the soil was not incorporated into the analysis. If it had been, the factor of safety would be significantly higher.

The large fill across the gully where soil sample No. 2 was taken is expected to have a factor of safety of approximately 1.4 if the fill slope is constructed at a slope of 1H:1V. The fill material should be compacted in lifts not exceeding 18 inches in depth and compacted by heavy machinery during placement. All rock fragments in excess of 18 inches should be removed from the fill. Rock fragments incorporated in the fill should be placed in a manner to minimize void space. It is recommended that the natural slope surface be prepared for the fill by removing vegetation and loose cobble and boulder sized rock fragments. Cobble and boulder sized rock fragments securely embedded into existing slopes may be left in-place provided adequate compaction is achieved adjacent to these fragments. We recommend that a series of narrow terraces, approximately 10 feet wide, be constructed to key the fill material into the natural slopes.

Stability of the slopes will be influenced by the degree of saturation of existing soils. Therefore, surface drainage must be channeled to prevent or at least minimize runoff over the slopes. Also, snow removed from the access road should be placed at the south end of the switchback to minimize the amount of moisture percolating into the fill slopes or road surface due to melting snow. We understand that erosion control mats will be placed on constructed slopes to minimize minor slides and sluffs.

We understand that boulders obtained from cut areas during construction, that are not incorporated in fill areas, will be placed on terraced portions of fill slopes. Boulders will be placed in a single lift on horizontal terraces to simulate natural conditions.

FILE 27437-002-162 BY ______ DATE ______ CHECKED BY ______ DATE ______



100 0 100 200

SCALE IN FEET

AD-1 INDICATES DRAINAGE AREAS THAT ARE DIVERTED THROUGH SEDIMENT PONDS OR ALTERNATE SEDIMENT CONTROL STRUCTURES

AU-1 INDICATES DRAINAGE AREAS THAT ARE DIVERTED BY DITCH AND/OR CULVERT TO OFF-SITE WITH LIMITED OR NO SEDIMENT CONTROL

CO-OP MINING CO.

PLOT PLAN

BEAR CANYON MINE

REFERENCE-

ADAPTED FROM DRAWING ENTITLED, "WATERSHED MAP; BEAR CANYON," BY CO-OP MINING CO., HUNTINGTON, UTAH, PLATE 7-5, DATED 5-6-91.

Dames & Moore

PLATE 1

DAMES & MOORE

Based on the slope stability analysis and observations made during the reconnaissance visit, it is our opinion that the cut and fill slopes will perform satisfactory and similar to those located along the Bear Creek Portal Access Road.

We appreciate the opportunity of visiting the site and assisting you with the expansion of the Bear Creek Mine. If you have any questions concerning this report or if we can assist you in any other way please call at your earliest convenience.

Sincerely,

DAMES & MOORE, INC.

C. Charles Payton

C. Charles Payton, C.E.G.
Associate

Russell L. Owens

Russell L. Owens, P.E.
Professional Engineer
State of Utah

RUSSELL L.
OWENS

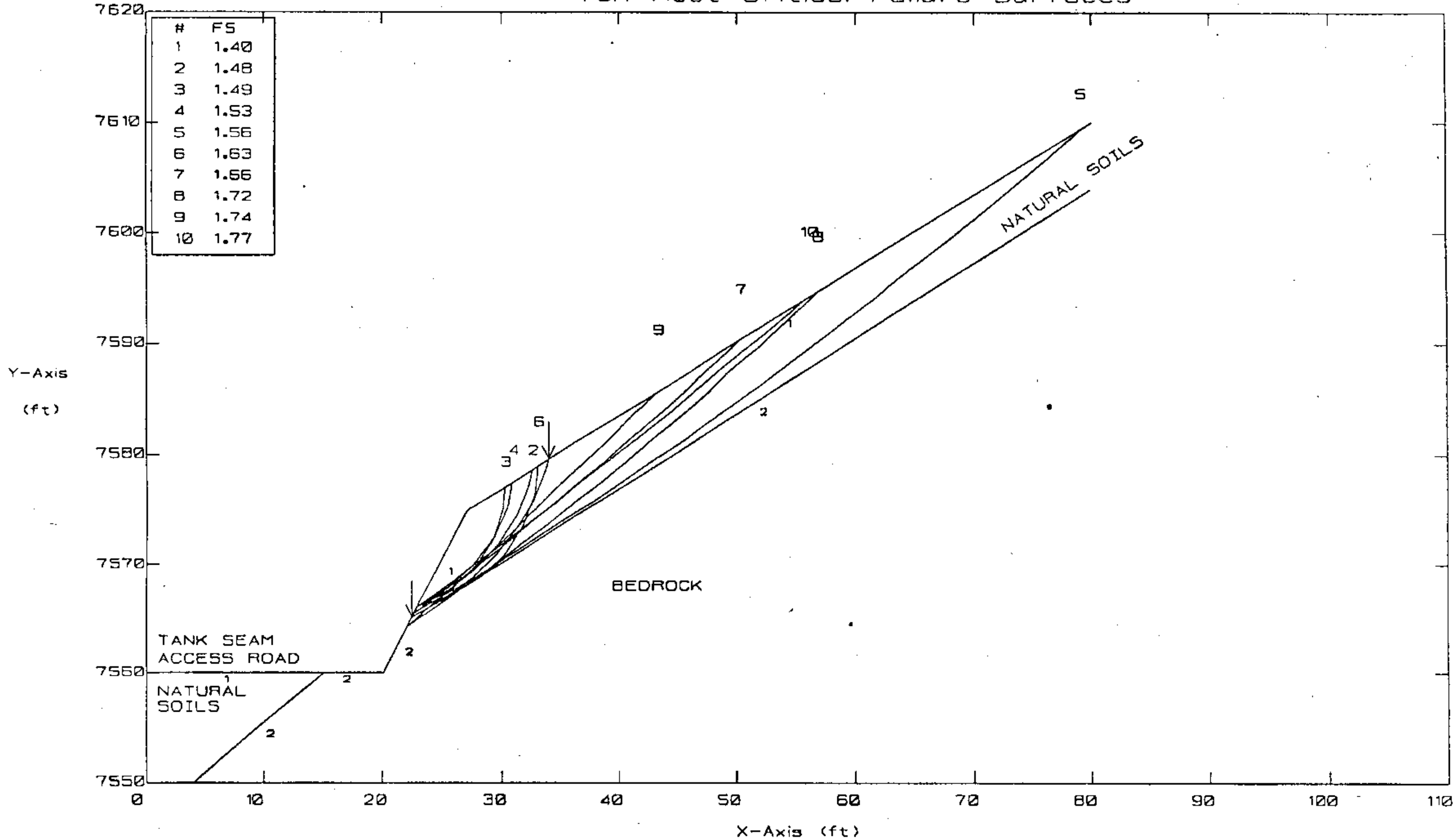
Attachments:

Plate 1 - Plot Plan
Plate 2 - Cut Slope Cross-Section
Plate 3 - Fill Slope Cross-Section

FILE ______ BY ______ DATE ______ CHECKED BY ______ DATE ______

CO-OP Mine 1H:2V Cut slope

Ten Most Critical Failure Surfaces



Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)
1	120	125	180	32
2	130	140	500	38

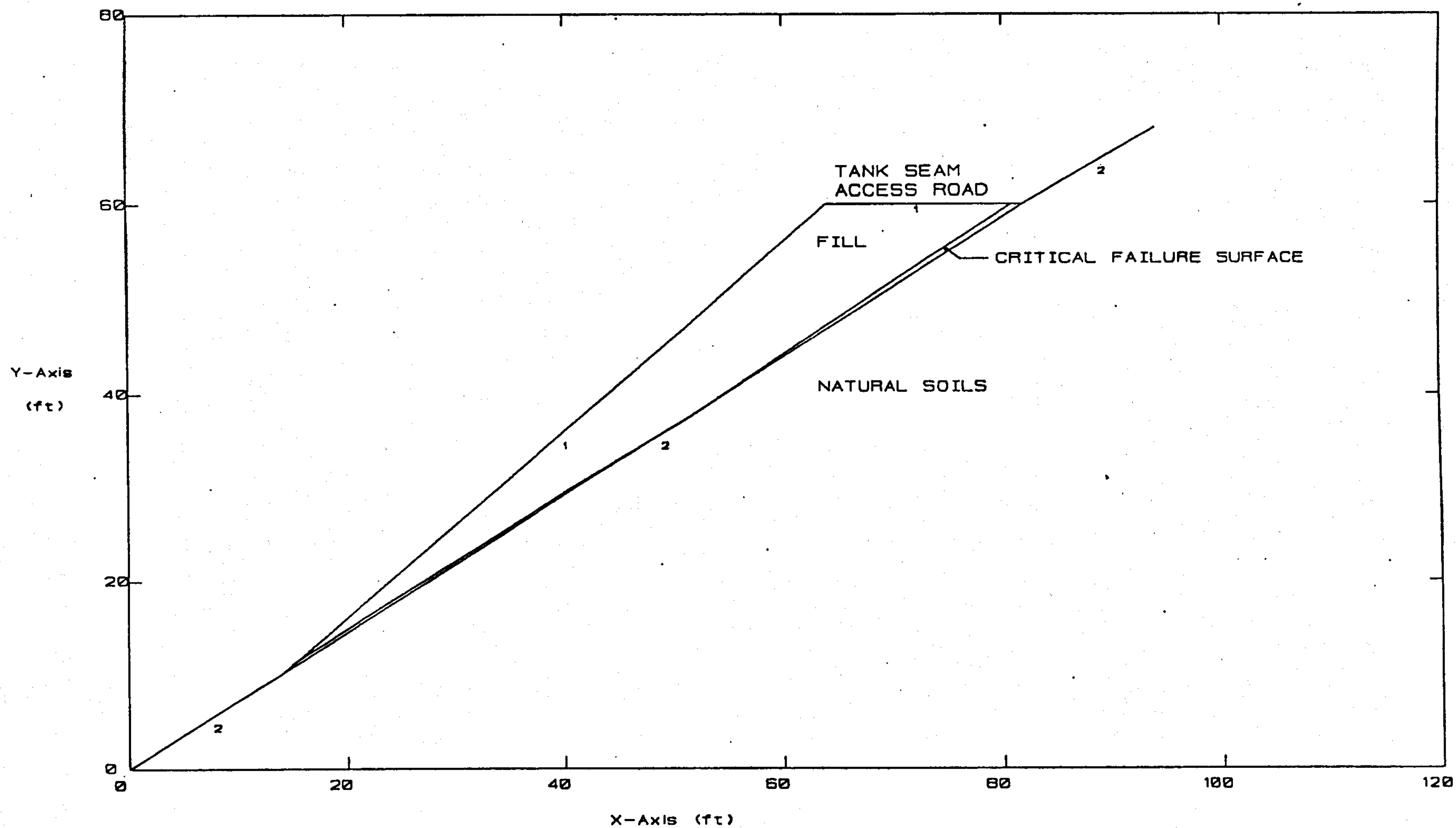
Dames & Moore

PLATE 2

FILE ______ BY ______ DATE ______ CHECKED BY ______ DATE ______

CO-OP Fill 1:1 FILL SLOPE

Specified Critical Failure Surface, Minimum FS=1.44



Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)
1	125	130	180	36
2	120	125	180	32

Dames & Moore

PLATE 3

DAMES & MOORE

127 SOUTH 500 EAST, SUITE 300, SALT LAKE CITY, UTAH 84102-1959
(801) 521-9255 FAX: (801) 521-0380

July 12, 1994

CO-OP Mining Company
P.O. Box 1245
Highway 31
Huntington Canyon
Huntington, Utah 84528

Attention: Mr. Charles Reynolds

RE: Clarifications to Tank Seam Portal Access Road Report

Dear Charles,

The Division of Oil, Gas, and Mining has asked for two clarifications concerning the Tank Seam Portal Access Road report, dated May 6, 1994. These clarifications include the potential for failure surfaces within the natural soils underlying fill areas of the Tank Seam access road and the use of 18 inch lifts for road construction.

The depth to bedrock along the Tank Seam Access Road is expected to vary from exposures at the ground surface to depths of 2 to 3 feet. The bedrock outcrops and soil deposits along the access road form a "stepped" slope. Plate 3 of the report presents a simplified natural slope in order to determine the factor of safety for failure surfaces within the fill. The natural slope was portrayed as a relatively smooth soil slope for ease of modelling since the potential of a failure surface extending through the natural slope, as opposed to failure within the fill, was considered remote. A model portraying a "stepped" slope with appropriate bedrock shear strength properties would confine critical failure surfaces within the road fill.

Dames & Moore's September 16, 1993 report recommended that the fill material utilized for the Tank Seam Access Road construction "be compacted in lifts not exceeding 8-inches in depth and all rock fragments cobble sized and larger should be removed from the fill". This recommendation was changed in our May 10, 1994 such that 18 inch lifts could be utilized and that rock fragments in excess of 18 inches could be incorporated into upper lifts provided the material adjacent to the rock fragments was properly compacted. The original recommendation of 8-inch lifts and removal of cobble size fragments is standard for structural fill underlying foundations to assure adequate bearing capacity and to minimize settlement. Since bearing capacity and minor settlement are not issues with the access road, we felt that 18 inch lifts would not reduce safety factors for the fill and would expedite construction provided the lifts were properly compacted to minimize void spaces.

We hope these clarifications are beneficial. If additional information is required, please do not hesitate to call.

Respectfully,

DAMES & MOORE, INC.

Russell L. Owens

Russell L. Owens, P.E.
Senior Geotechnical Engineer

Tank Seam Fill

As Constructed

Slope Stability Analysis

Introduction

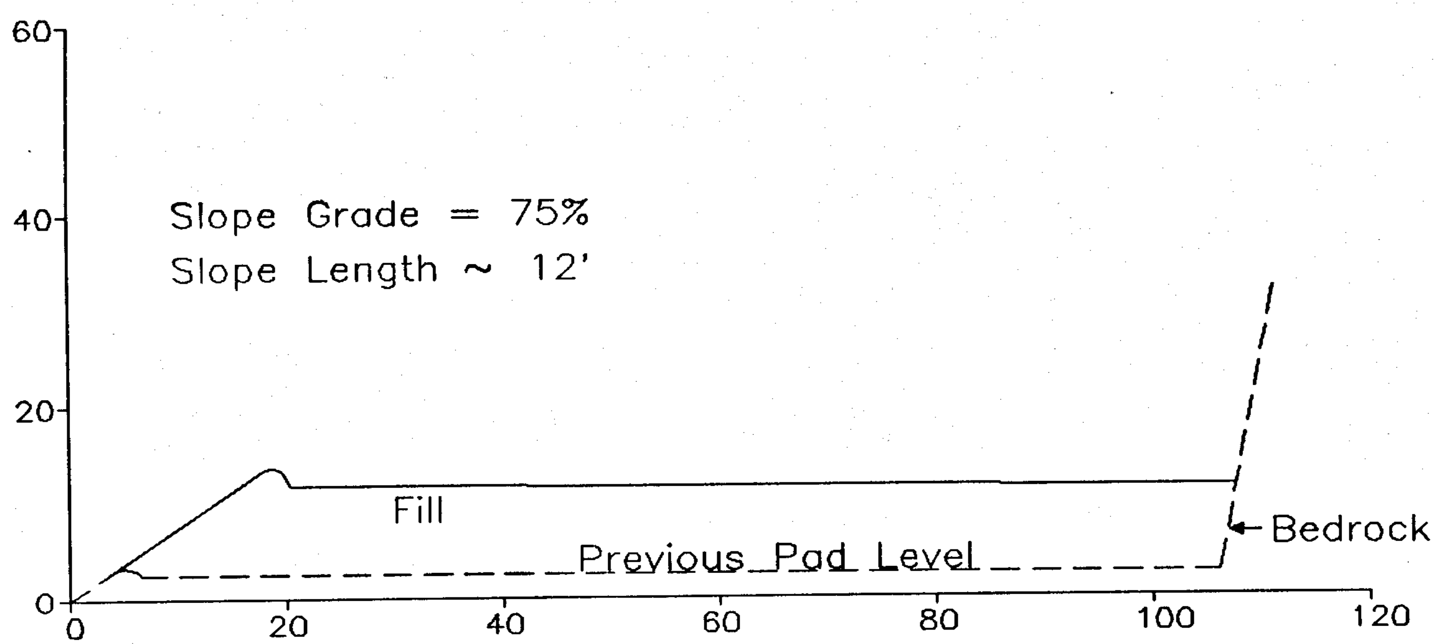
The following section contains slope profiles and a stability analysis for each fill slope along the Tank Seam Access Road. Final backfilling and grading along the access road was completed in November 1994.

Soil samples for the stability analysis were collected from the fill material prior to placement of the fill. Analysis of the soil samples were performed by Dames & Moore. The slope stability analysis and safety factors were generated by Dames and Moore.

The location of the five fill areas are as follows (Stations are shown in Figure 5G-4). TSF-1 fill is located on the upper storage pad in the area of station 1+00. TSF-2 fill is located in the area of station 8+00 and 9+00 (large fill areas). TSF-3 fill is located between stations 10+00 and 11+00. TSF-3 fill is located at the switchback, in the area of Station 15+00. TSF-5 fill is located in the area of Station 25+00.

The following figures show detailed as constructed slope profiles of each fill area. Following the profiles is a slope stability analysis, which analyzes each fill area.

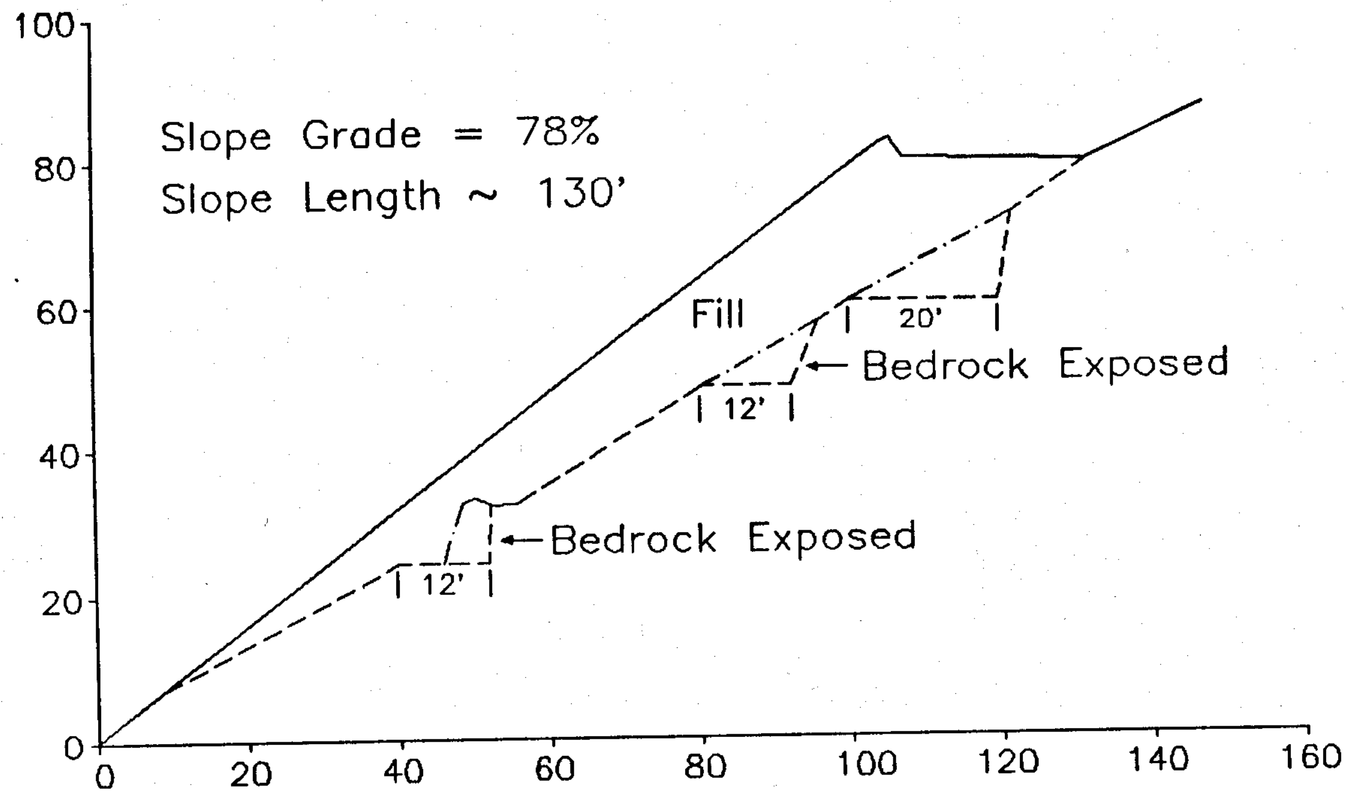
TSF-1



Constructed Slope
Fill Base

Scale: 1" = 20'

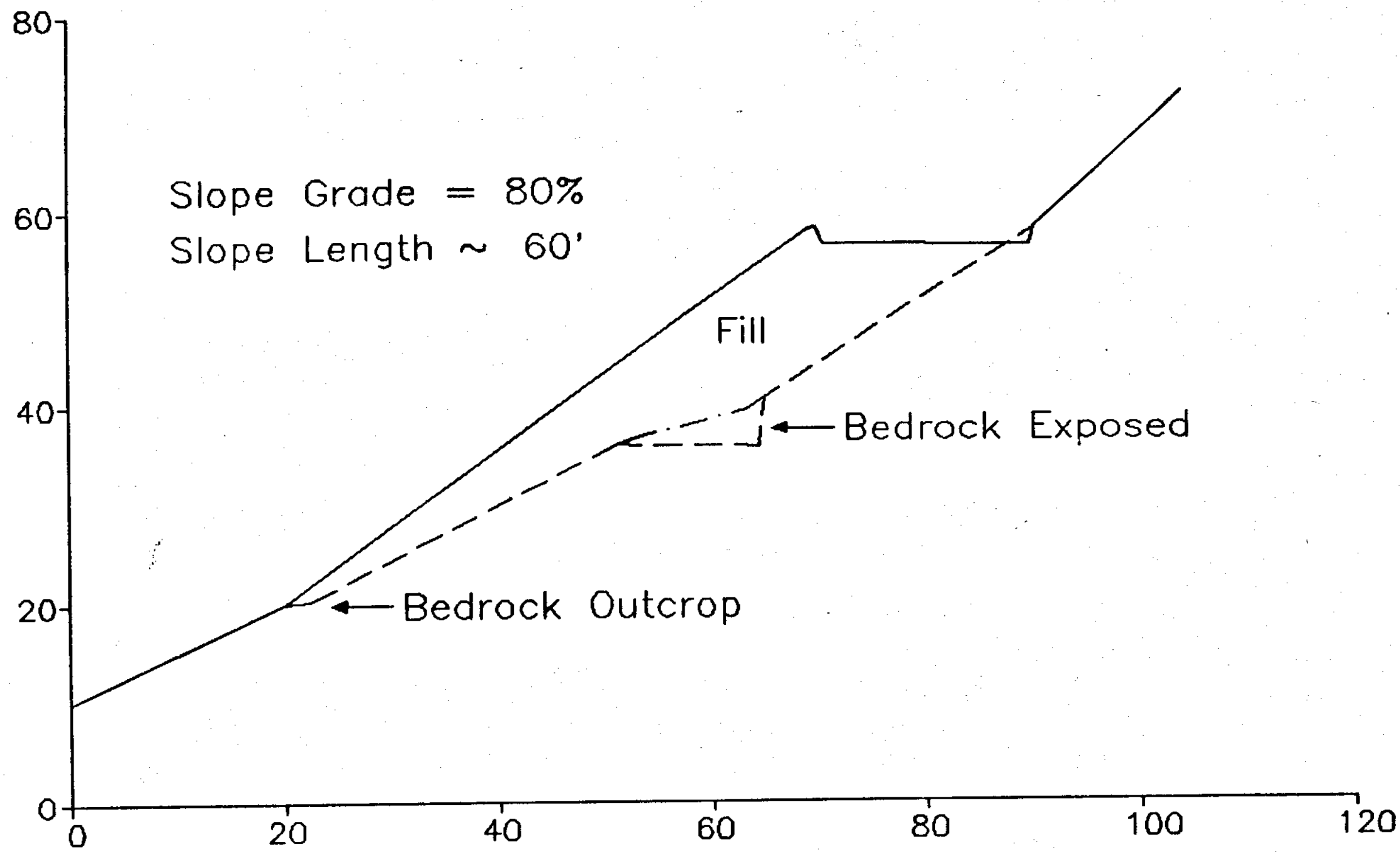
TSF-2



Constructed Slope
Base of Fill
Natural Slope
(where different from fill base)

Scale: 1" = 30'

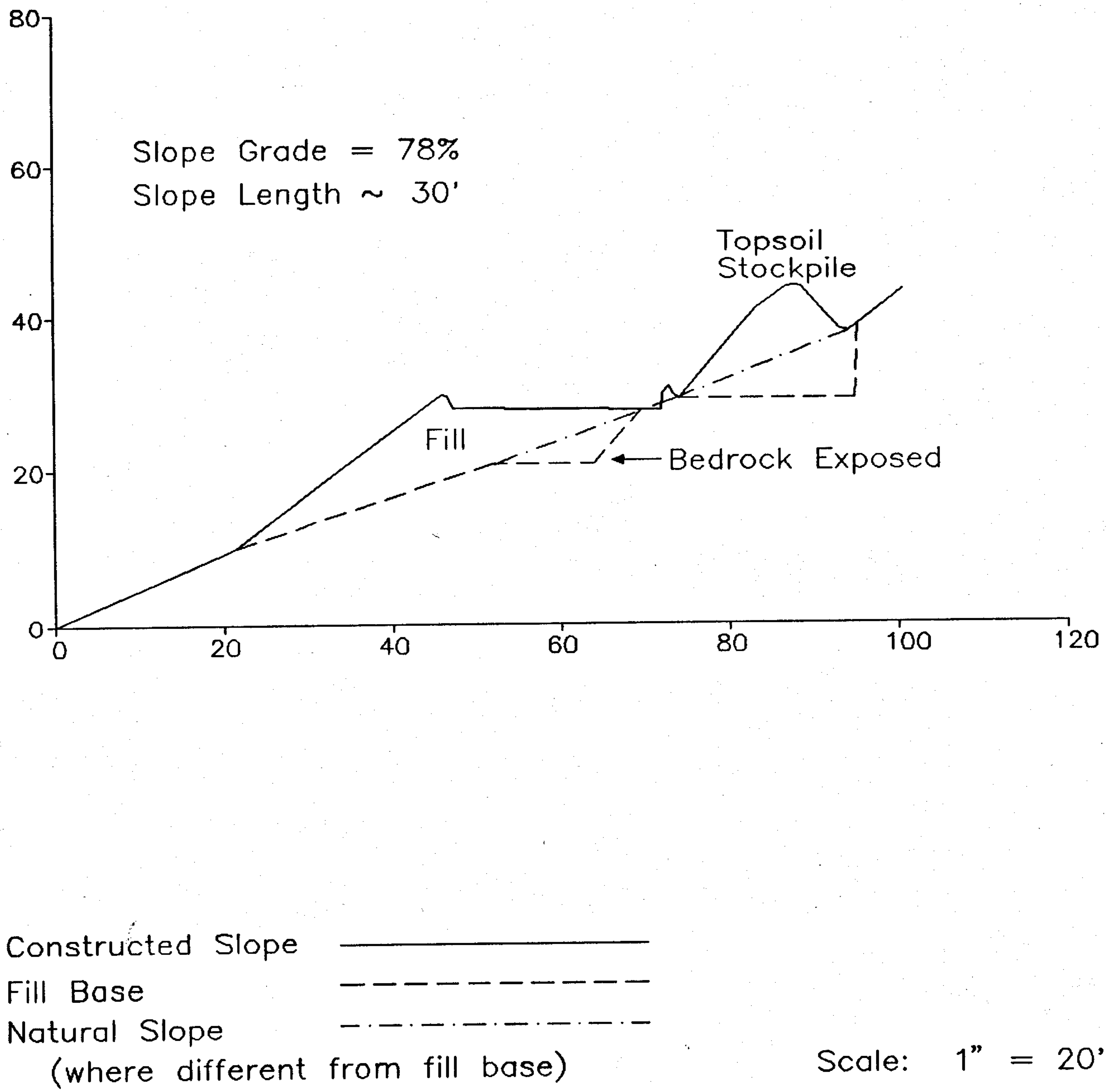
TSF-3



Constructed Slope ——————
Fill Base — — — — — —
Natural Slope — · — · — · —
(where different from fill base)

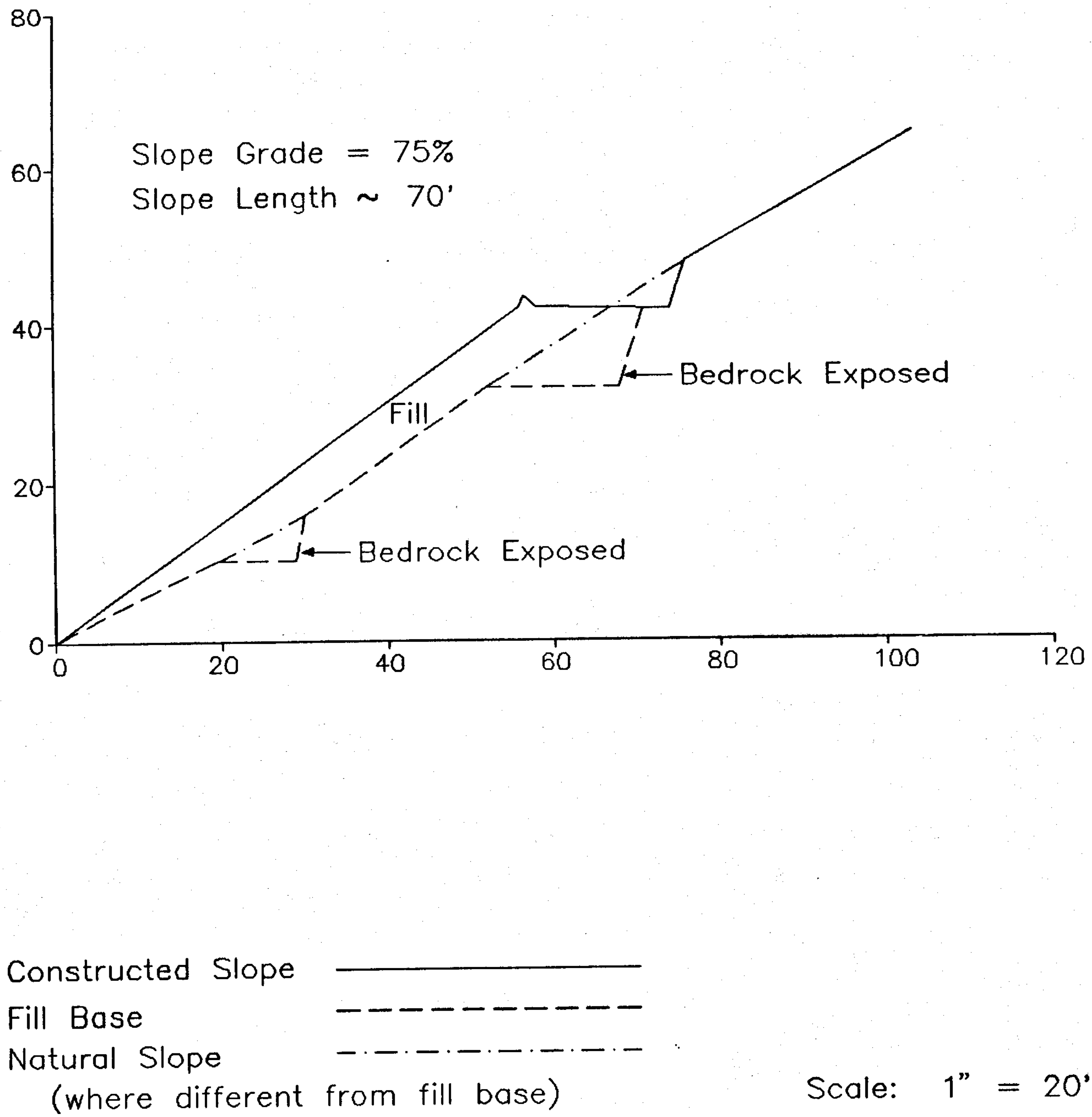
Scale: 1" = 20'

TSF-4



Scale: 1" = 20'

TSF-5



Scale: 1" = 20'

DAMES & MOORE

127 SOUTH 500 EAST, SUITE 300, SALT LAKE CITY, UTAH 84102-1959
(801) 521-9255 FAX: (801) 521-0380

December 5, 1994

CO-OP Mining Company
P.O. Box 1245
Highway 31
Huntington Canyon
Huntington, Utah 84528

Attention: Mr. Charles Reynolds
Mining Engineer

Report
Geotechnical Consultation
Tank Seam Portal Access Road
Job No. 27437-001-162

INTRODUCTION

This report presents the results of stability analyses performed by Dames & Moore for Tank Seam Portal Access Road fill sections for CO-OP Mining Company.

PURPOSE & SCOPE OF STUDY

The purpose and scope of this study was defined in our proposal dated October 20, 1994. In accomplishing the work the following services were performed.

1) Analyzing laboratory tests to determine appropriate estimates of soil strength parameters to be utilized in the subsequent analyses.

2) Modeling five separate fill slope sections. "As built drawings of the slopes were supplied by CO-OP mine.

3) Compiling data into this document that summarizes laboratory tests data and analyses results.

LABORATORY DATA

The laboratory data used in our engineering analyses were obtained from mechanical grain size analyses, compaction tests, and consolidated drained direct shear tests. Initial results for sample TSF-3 seemed low, consequently a second sample, designated TSF-6, was collected and tested. Results of the two tests were averaged and used for modeling section 3. The test results are summarized in the following paragraphs.

MECHANICAL ANALYSES

To aid in classifying the soils mechanical sieve analyses were performed on bulk samples collected from fill that was to be placed at each fill section. Results of the gradation analyses are presented in Table 1.

Table 1
Mechanical Analyses Results

Sample Number	USCS Classification	Percent Gravel	Percent Sand	Percent Fines
TSF-1	SC-SM	23.9	43.9	32.2
TSF-2	SC-SM	25.4	35.0	39.6
TSF-3	SC-SM	25.2	27.8	47.0
TSF-4	CL-ML	17.4	23.2	59.4
TSF-5	CL-ML	17.6	19.2	63.2
TSF-6	SC-SM	26.7	30.1	43.2

COMPACTION TESTS

Compaction tests were performed on bulk samples collected from fill material that was to be placed at each fill section. Results of the gradation analyses are presented in Table 2.

Table 2
Compaction Test Results

Sample Number	USCS Classification	Optimum Moisture Content %	Maximum Dry Density PCF
TSF-1	SC-SM	10.3	124.4
TSF-2	SC-SM	7.9	131.7
TSF-3	SC-SM	6.3	139.7
TSF-4	CL-ML	9.2	128.9
TSF-5	CL-ML	9.6	132.4
TSF-6	SC-SM	7.8	136.6

DIRECT SHEAR TESTS

Direct Shear tests (consolidated drained) were performed on remolded bulk samples which were collected from fill that was to be placed at each of the fill sections. Samples were compacted to 95% of the maximum dry density as determined in the compaction tests. In accordance with ASTM 3080 the plus 3/8 material is removed prior to remolding. The plus 3/8 inch fraction of the samples ranged from 12.6 to 20.5 percent. Subjective interpretation was necessary for some tests due to scatter in the data points. The results are summarized in Table 3.

Table 3
Direct Shear Tests Results

Sample Number	USCS Classification	Friction Angle	Cohesion psf
TSF-1	SC-SM	38.7	168
TSF-2	SC-SM	28.0	290
TSF-3	SC-SM	36.6	0
TSF-4	CL-ML	40.6	15
TSF-5	CL-ML	28.2	510
TSF-6	SC-SM	36.5	162

SLOPE STABILITY ANALYSES

Analyses of the stability of the proposed fill sections were performed using a two-dimensional, limit equilibrium stability program called PCSTABL6. An automatic search routine was employed in each case to determine the failure surfaces with the lowest factors of safety. In all cases the fill was modeled assuming unsaturated conditions.

The geometry of each section was modeled based on the "as built" drawing provided by CO-OP. In each case 95% of the maximum dry density as determined by the compaction tests was input for the soil unit weight. Friction angles and cohesion were obtained from the direct shear test results. Bedrock strength properties were input to reflect significantly higher strength values than the fill material in order to determine the factors of safety of the fills.

STABILITY ANALYSES RESULTS

The results of our analyses show factors of safety in acceptable ranges. For sections 1 and 5, the minimum calculated safety factors were above 2.0. For section 2 the minimum calculated safety factor was 1.33. For section 3 the minimum calculated safety factor was 1.36. For section 4 the minimum calculated safety factor was 1.50.

It is our opinion that the fill slopes should generally perform satisfactorily. However, due to limited sampling and testing and potential variabilities in fill placement, we recommend periodic inspection of the fill slopes for any signs of distress, particularly at sections 2 and 3, and after periods of high precipitation or snowmelt.

oOo

DAMES & MOORE

The following Plates are attached and complete this report.

Plate 1 - Fill Slope Cross Section TSF-1
Plate 2 - Fill Slope Cross Section TSF-2
Plate 3 - Fill Slope Cross Section TSF-3
Plate 4 - Fill Slope Cross Section TSF-4
Plate 5 - Fill Slope Cross Section TSF-5

Sincerely,

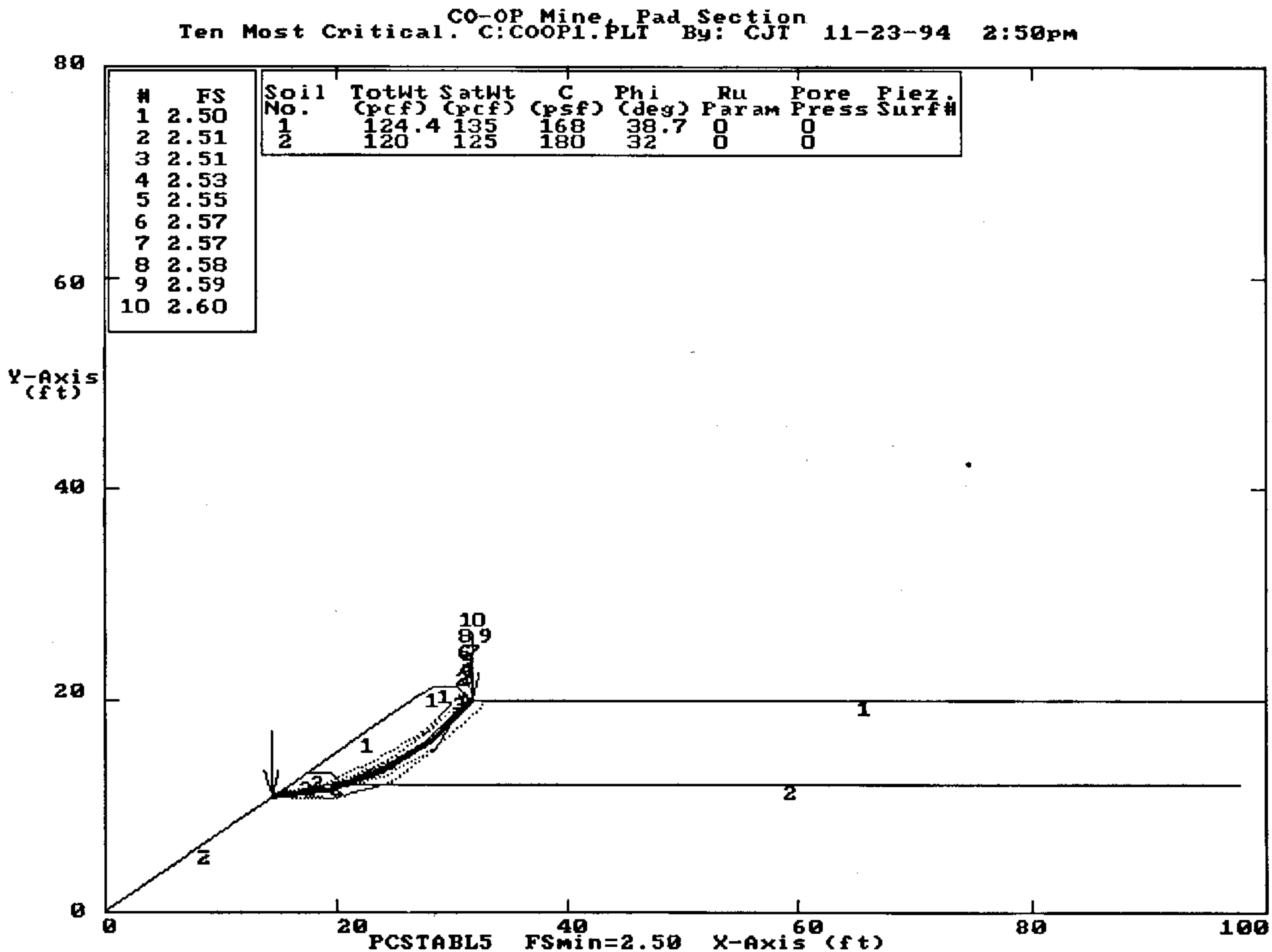
DAMES & MOORE, Inc.

LICENSED PROFESSIONAL ENGINEER
93-180048-2202
RUSSELL L.
OWENS
STATE OF UTAH

Russell L. Owens, P.E.
Senior Geotechnical Engineer
Professional Engineer, N. 180048
State of Utah

Curtis J. Tanner, P.E.
Staff Engineer
Professional Engineer No. 184573
State of Utah

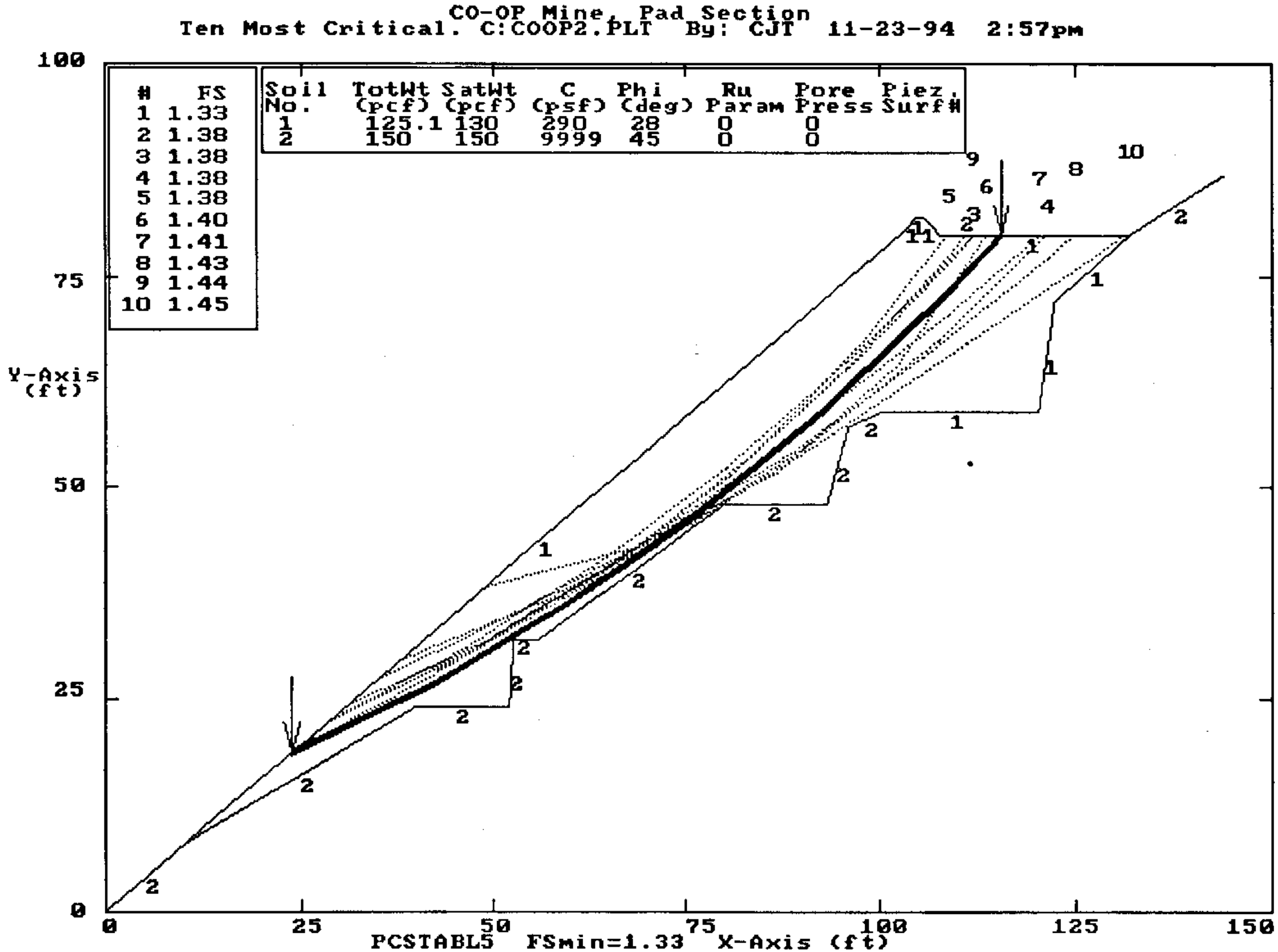
TSF-1



CO-OP Mine, Pad Section
Ten Most Critical. C:COOP1.PLT By: CJT 11-23-94 2:50pm
FS
1 2.50
2 2.51
3 2.51
4 2.53
5 2.55
6 2.57
7 2.57
8 2.58
9 2.59
10 2.60
Soil No. | TotWt (pcf) | SatWt (pcf) | C (psf) | Phi (deg) | Ru Param | Pore Press | Piez. Surf#
1 | 124.4 | 135 | 168 | 38.7 | 0 | 0
2 | 120 | 125 | 180 | 32 | 0 | 0
Y-Axis (ft)
PCSTABL5 FSmin=2.50 X-Axis (ft)

PLATE 1

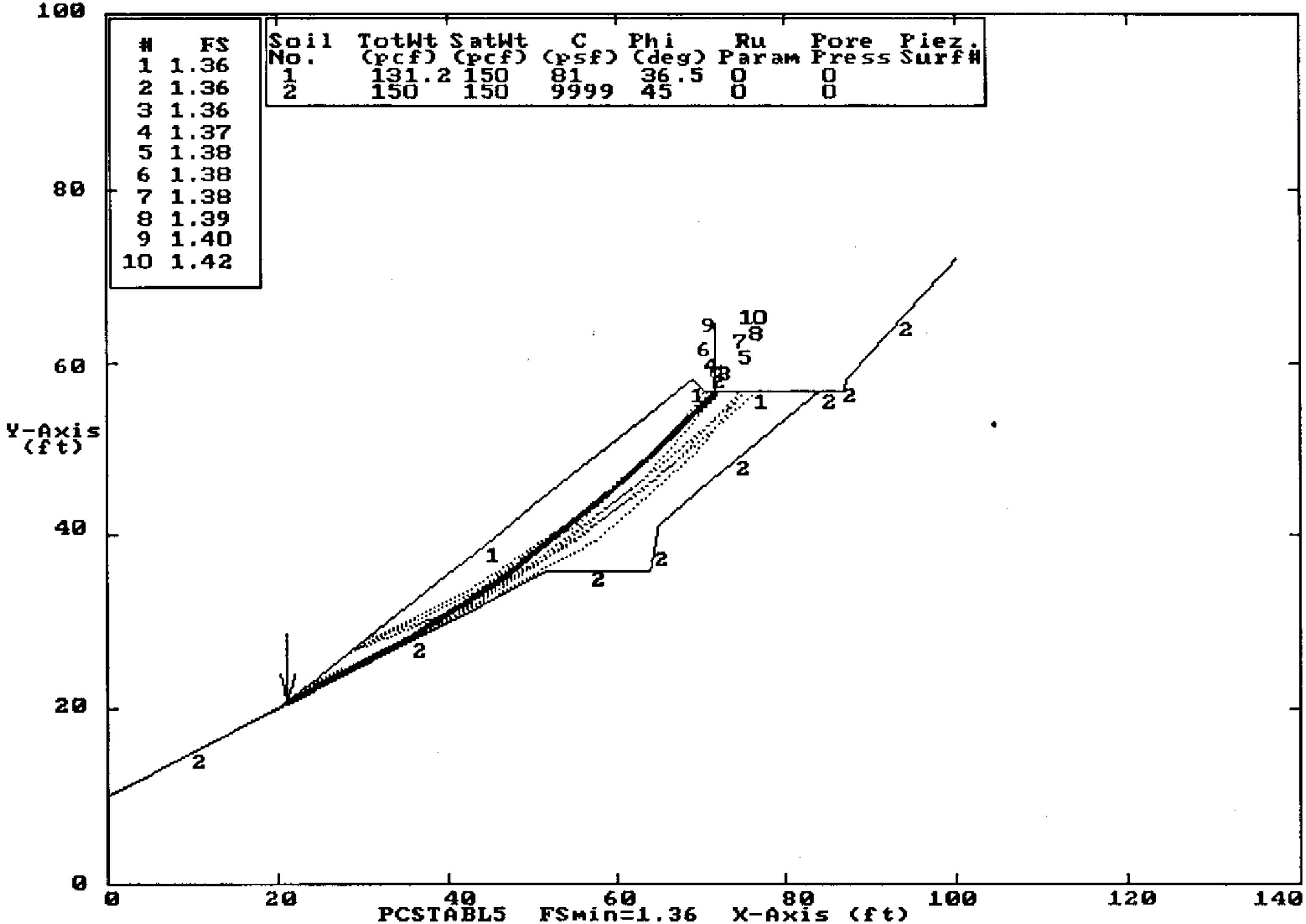
TSF-2



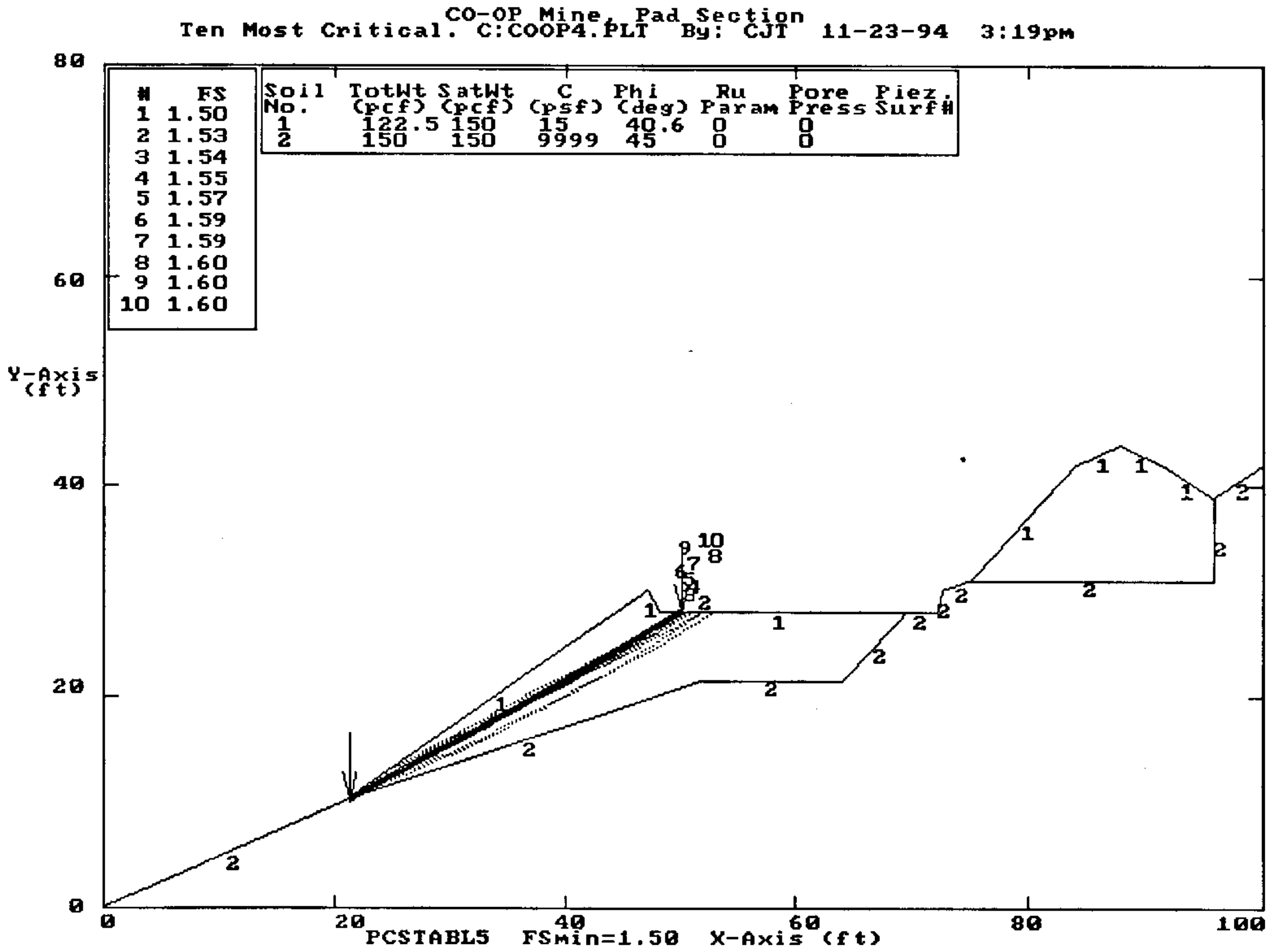
CO-OP Mine, Pad Section
Ten Most Critical. C:COOP2.PLT By: CJT 11-23-94 2:57pm
FS
1 1.33
2 1.38
3 1.38
4 1.38
5 1.38
6 1.40
7 1.41
8 1.43
9 1.44
10 1.45
Soil No. TotWt (pcf) SatWt (pcf) C (psf) Phi (deg) Ru Param Pore Press Piez. Surf#
1 125.1 130 290 28 0 0
2 150 150 9999 45 0 0
Y-Axis (ft)
PCSTABL5 FSmin=1.33 X-Axis (ft)

TSF-3

CO-OP Mine, Pad Section
Ten Most Critical. C:COOP3.PLT By: CJT 11-23-94 3:25pm



TSF-4


CO-OP Mine, Pad Section
Ten Most Critical. C:COOP4.PLT By: CJT 11-23-94 3:19pm
FS
1 1.50
2 1.53
3 1.54
4 1.55
5 1.57
6 1.59
7 1.59
8 1.60
9 1.60
10 1.60
Soil No. | TotWt (pcf) | SatWt (pcf) | C (psf) | Phi (deg) | Ru Param | Pore Press | Piez. Surf#
1 | 122.5 | 150 | 15 | 40.6 | 0 | 0
2 | 150 | 150 | 9999 | 45 | 0 | 0
Y-Axis (ft)
PCSTABL5 FSmin=1.50 X-Axis (ft)

TSF-5

CO-OP Mine, Pad Section
Ten Most Critical. C:COOP5.PLT By: CJT 11-23-94 3:22pm

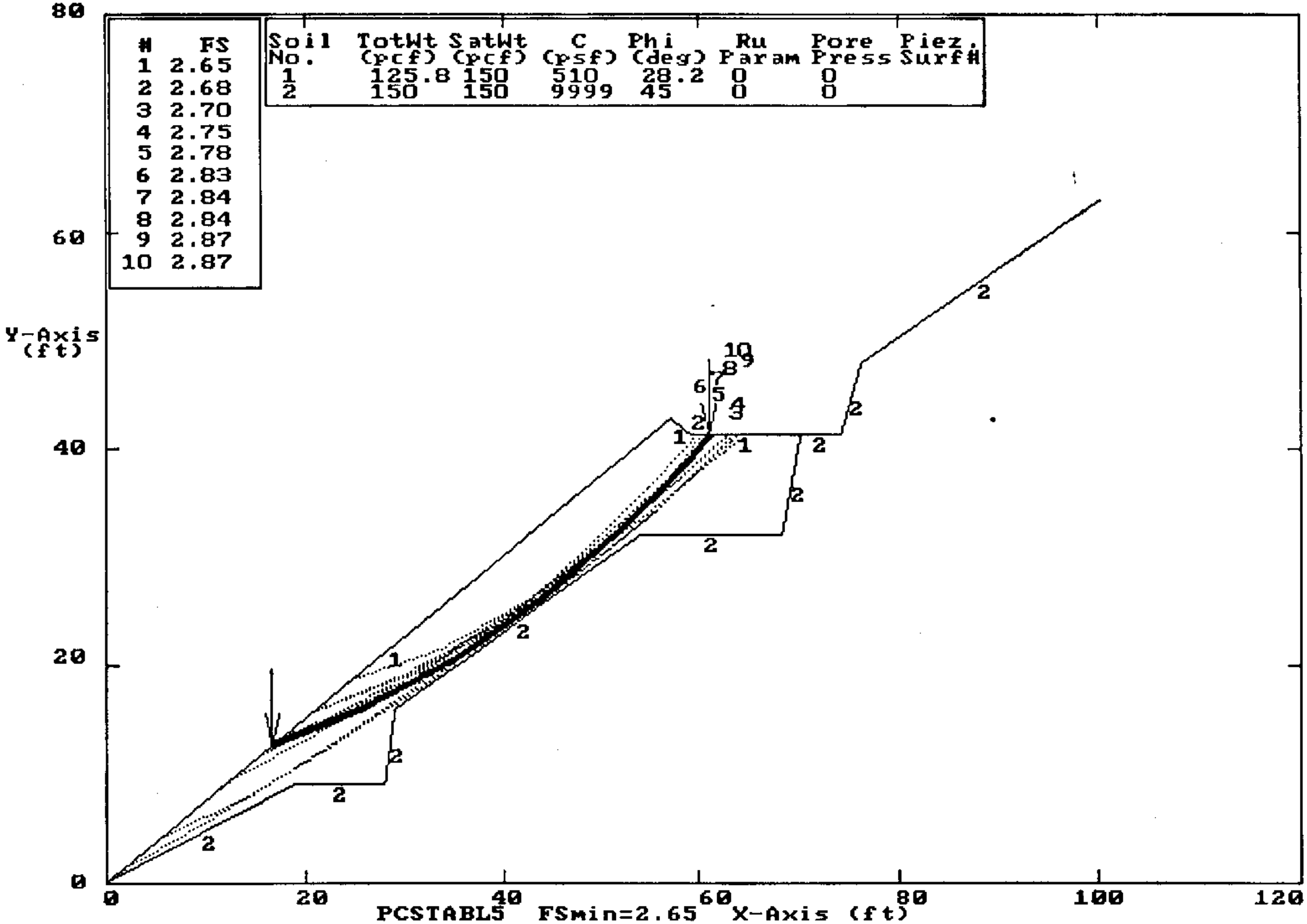


Table 5G-2 Tank Seam Road As-built Cut and Fill Summary

Station	Fill (-) Volume* (cu yd)	Cut (+) Volume* (cu yd)	Volume Cumulative (cu yd)	Station	Fill (-) Volume* (cu yd)	Cut (+) Volume* (cu yd)	Volume Cumulative (cu yd)
0+00			0	14+00			-9,576
	1,140	0			581	79	
1+00			-1,140	15+00			-10,078
	2,850	0			844	110	
2+00			-3,990	16+00			-10,812
	3,135	0			0	798	
3+00			-7,125	17+00			-10,014
	219	463			57	886	
4+00			-6,881	18+00			-9,185
	76	1,123			0	743	
5+00			-5,834	19+00			-8,442
	48	608			52	254	
6+00			-5,274	20+00			-8,240
	154	719			117	555	
7+00			-4,709	21+00			-7,802
	29	697			78	843	
8+00			-4,041	22+00			-7,037
	2,422	185			225	357	
9+00			-6,278	23+00			-6,905
	4,462	79			679	60	
10+00			-10,661	24+00			-7,524
	230	678			124	1,008	
11+00			-10,213	25+00			-6,640
	283	138			180	3,730	
12+00			-10,358	26+00			-3,090
	29	520			340	2,015	
13+00			-9,867	27+00			-1,415
	49	340			308	1,657	
14+00			-9,576	28+00			-66

*Cut and fill volumes measured using Quicksurf Version 5.1 3-D modeling software package, copywrite 1995, Schreiber Instruments, Inc., based on premining contours form 1991 aerial survey and contours shown on Plate 2-4E from 1995 aerial survey.

Figure 5G-5. Tank Seam As-built Road/Pad Stations Map